The Glass Industry

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Glass Division Meetings Notably Successful at Gathering of the American Ceramic Society

SELDOM if ever, according to qualified judges, has a meeting of the Glass Division been more interesting or instructive than the gatherings held at Cleveland last week simultaneously with those of the other divisions at the annual meeting of the American Ceramic Society.

The Glass Division headquarters were at the Hollenden Hotel. The published program was adhered to quite closely with the exception of practically only one paper whose author was not present. The majority of the papers presented are briefly reviewed in this number, including in fact, nearly all that appeared on the technical program. Their plans to organize a new Materials and Equipment Division was successfully carried out by the group interested in such products, the proposal being favorably voted on at a special meeting held for that purpose.

The New Division

The organization meeting, attended by fifty or more members, was held at 2 p.m. on Sunday, February 22, at the Hotel Hollenden, and was called to order at 2:01 by Ross Purdy, secretary of the society. Order was maintained by a strictly sergeant-major command—"Sit down!" to all late arrivals.

Mr. Purdy said he had been secretary of the society for ten years, and in that time had seen the existing divisions become organized and conscious of their community of interest. In the main they were essentially technical divisions, and were doing very good work, but since technical men are to a very great extent confined to their own plants, it was not practicable for them to act as emissaries of the society. For that they had to depend on the business men, the executives, and the salesmen of the industry, who had the outside contacts. Up to date the Society had not made the appeal it should to this class of men, and the formation of a division dealing with raw materials and equipment would be a step considerably in advance of the present organization. Such a division would have to be organized on a somewhat different footing from the rest; its business would not be to hold meetings of the type held by the other divisions, but to "sell the Society" to the industries of the country.

The meeting appointed L. E. Riddle, Jr., to be Chairman, and he forthwith took the chair. Henry Kleinfeldt was made Secretary, and V. V. Kelsey, Treasurer. F. G. Lord was appointed chairman of the program committee and the chairman (Mr. Riddle) was authorized to appoint such committees as might be necessary for one year until the division can become thoroughly organized. A good deal of the division's program will center in the Ceramic Exposition of 1933 and preparations therefor.

Mr. Purdy suggested that the new division give prompt attention to the problem of its relations with the trade journals. He also took occasion to remark that the *Journal of the American Ceramic Society* does not go out to obtain such advertisements in competition with the trade press, though it needs a substantial amount of advertising to help pay its way.

General Orton Retires

On Monday morning at 10:00 A.M., General Orton delivered his retiring presidential address. The discourse falls naturally into two parts, the earlier dealing with the affairs of the Ceramic Society, and by no means convincing to the reviewer, and the second and important part dealing with the affairs of the nation, which carried conviction and met with the approval of the large audience that attended.

General Orton stated that the Society had now been in existence just one-third of a century; it had witnessed the formation of a number of Divisions, any one of which was today more powerful in the affairs of the nation and the world, than the parent society in its early years. This year would see two innovations—the new Division for Materials and Equipment, and the induction of the first band of Fellows of the Society. The original objective of the Society had been largely attained; new objectives had now to be formulated, and one of these was the application of principles, that had worked so well on the technical field, to the managerial sections of the industry.

The Century of Progress Exposition in 1933 will set forth to explain the change that has come over the world in the last hundred years as a result of the application of science to life. The part that ceramics has played must be set forth in a joint effort, or it will be swamped under the exhibitors of steel and electrical paraphernalia.

General Orton then went on to review the advantage conferred by nature upon the territory that is the United States, and the advantages added thereto by an able populace. These could not be gainsaid, but he then proceeded to list some serious deficiences and handicaps. These were:

(1) An extravagant provincialism that worshipped too much the 100% Americanism idea, refusing to see good in other nations.

(2) An archaic system of government that was a disgrace to the land and refused to adapt itself to the needs of the times.

(3) A wretchedly antiquated judicial system so that justice was slow, rare, and inefficient.

(4) A very unsatisfactory capitalistic organization concentrating 95% of the country's wealth in the hands of 5% of the people, and tending automatically to make this discrepancy increase continually.

General Orton discussed some of the difficulties in detail, and urged reform, appealing to the audience to exercise their responsibilities, not only as ceramists, but as citizens, to mend the ways of the country.

Ross Purdy followed with a brief comment, very emphatically delivered, on the outstanding success the meeting was becoming. The most optimistic estimate of the attendance had been far exceeded and the end was not yet in sight.

Dr. Matthew Luckiesh, of the General Electric Company, then gave an address on the significance to human life of the modern era of experimentalism. The Greeks philosophized, but the modern world experiments, and the same brain power produces thereby a vastly greater result. The experimental age is about 300 years old. It is a level 100 years since Michael Faraday's epochal discovery of the connection between magnetism and electricity, which has finally reduced the whole physical world to two fundamental units, electrical charges and radiant energy, apparently mutually convertible.

Dr. Luckiesh expected men to visit the moon during the present century and possibly to visit Mars. He expected in time to utilize the finite velocity of light to see the Egyptians making pottery 6,000 years ago, and to prognosticate the future in a way not now possible. He believed in the existence of many other worlds inhabited by thinking beings, and in our ability to communicate with them, not by the Morse code, but by television, since vision was a universal language, understood at once by total strangers.

On Tuesday, February 24, at midday, a luncheon was held in the Assembly Room of the Hollenden Hotel and after a short business session the Cove Point movies, presented by THE GLASS INDUSTRY, were thrown on the screen. These were followed by a Canadian National Railway film showing fishing scenes in the Pickerel River District of the Georgian Bay country in Canada to which the glass division is invited for its summer meeting in 1931. Both films met with a very good reception.

Some of the Glass Division Papers

Desirable Tariff Revision Concerning Original Works of Art in Glass

BY ALEXANDER SILVERMAN, UNIVERSITY OF PITTSBURGH
Reviewed by James Bailey

In a brief review of present tariff regulations it was pointed out that numerous original works of modern art in glass can be imported duty free under bond requiring continuous public exhibition in museums and the like, also antiques over 100 years old are not dutiable. Provisions of paragraph 1807, giving articles entitled to entrance under the free list of the Act of 1930, is so worded as not to specifically include art objects in glass. A list of specific changes was given so as to clarify the meaning and to permit free entrance of art glass originals. Similarly paragraph 1547 of the tariff act of 1930 under Schedule 15—Sundries was quoted. A discussion and various decisions followed. Most art glass not for museum exhibition is subject to 20% duty. It was pointed out that these objects do not directly compete with articles produced in this country and should be admitted duty free, the author maintained.

The recommendations as regards revision were presented to the Society in the form of the following resolution:

"Therefore be it resolved that the American Ceramic Society recommend to the commissioner of customs or properly authorized parties selected by him that:

(1) Original oil or mineral paintings on plain, mottled, or cased glass whether unfired or fired.

(2) Original enamels on plain, mottled, or cased glass whether applied and fired for normal enamel effects or enamels which have penetrated the glass for the production of two tone effects, smoother or rough; or underglaze paintings or enamels, viz: those which have been applied to the glass, fired in, and then coated with a subsequently applied coat of transparent enamel.

(3) Original design on plain, mottled, or cased glass made with instruments harder than glass itself, for example, the diamond point, tungsten carbide, etc.

(4) Original etchings on plain, mottled, or cased glass whether produced with acids alone or by these in combination with painting, engraving, enameling, sculpturing, etc.

(5) Original sculptures whether produced by tooling a mass of plain, mottled, or cased glass, cold or hot, or by producing a model of some other material from which a mold is prepared in which an original, and not more than two replicas or reproductions are produced.

(6) Artistic designs produced on glass, plain mottled or cased, by applying small bits of colored glass to the hot gather and rewarming a firing to firmly affix the design to the glass object.

(7) Artistic designs produced by laying small bits of glass on a refractory mass melting the design in a furnace and gathering it on a hot bubble or other mass of glass, subsequently warming in or firing the mass so that the design becomes firmly affixed.

(8) Artistic models or masses of glass which will be imbedded in other glass by subsequent dipping or rolling in the other glass. This paragraph refers to artistic cores in candlesticks, etc.

(9) The artistic laying together of small bits of glass rock, plain or multi-colored, for the production of unusual millefiori effects or the production of exceptionally artistic designs in laticino.

(10) Original engravings on plain, mottled, or cased glass whether produced alone or in combination with effects described in preceding paragraphs.

(11) Artistic effects produced with transparent enamels or soft glasses which are melted into the interstices in filagree or perforated metal objects.

Be included under paragraph 1807 of the Tariff Act of 1930 or a related or separate paragraph in modification of said Act, or for inclusion in the Tariff Act of 1931 or such subsequent legislation as may be enacted at the time when final consideration is given to these recommendations."

The above shall apply only to original works of art, each having an affidavit by the artist who produced them.

The Design and Construction of Polariscopes for Use in the Glass Factory

BY C. D. SPENCER, GENERAL ELECTRIC COMPANY

Reviewed by James Bailey

The qualifications of a polariscope for viewing small glass articles such as electric light bulbs was outlined. A number of the older types of polariscopes were pictorially shown. These earlier types showed a tendency to be complicated in structure and were usually made of wood. Because of the reduction in illumination due to polarization it is necessary to use a relatively large lamp such as a 1,000 watt or 1,500 watt lamp. The heat from these lamps warped the wood cases and caused rapid disintegration. The final design was a rectangular metal case consisting of two parts. The lamp was in a separate reflector on top of the rear portion of the housing. Its rays passed through a ground glass into a black glass mirror placed at such an angle that the reflected rays were at the critical angle with the Nicol prism eye piece. Between the mirror and eye piece was a metal light shield having a round hole about 8" in diameter. This hole was covered with a clear glass. The mirror being in the closed metal rear portion was thus protected from factory dust. The Nicol prism was used in connection with a sensitive tint plate which at the same time increased the sensitivity of the instrument and tended to equalize the appearance of the field of view.

One of the latest developments is the use of two Nicols placed side by side and separated by the interpupillary distance thus making the instrument usable with both eyes, and hence showing the objects in perspective.

Crystallization Phenomena in Some Glasses of the Pyrex Type

BY GEORGE W. MOREY, GEOPHYSICAL LABORATORY, WASHINGTON, D. C.

Reviewed by Donald E. Sharp

Dr. Morey reviewed briefly some results obtained on three Corning glasses of the Pyrex type, namely G702EJ, G702P and G702GO. All these are high silica glasses. The liquidus temperatures of the three are, respectively, 1077° C., 1041° C., and 1035° C. The glasses were much more difficult to crystallize than soda-lime glasses of the same liquidus temperature. Examination of a sample of G702EJ held at 850° C. for 15 days showed presence of both tridymite and crystobalite. Crystallization of heated rods took place from the surface inward, but if the original surface were removed by grinding, the crystallization took place in the body of the glass.

A Quantitative Experiment in Glass Fining

R. K. DAY, CORNING GLASS WORKS

Reviewed by Donald E. Sharp

These experiments were started in an attempt to find out the length of time required to get glass free from seed under completely controlled conditions. The variables to be considered are the batch, crucible, temperature, temperature gradient, atmosphere, time and heating-up time. A common soda-lime batch was used, and melts were made in platinum-rhodium crucibles in a specially constructed platinum-wound electric furnace. It was found possible to determine the point at which the glass became seed-free with considerable accuracy by making several melts for different times at the same temperature and comparing the samples. It was found that the fining times plotted against temperatures gave smooth curves but so far no simple relation has been found between fining time and viscosity of the glass. Surface tension is apparently without marked effect. It was brought out in the discussion that the experiments made so far were preliminary in character, and that the chief point to be gained is that it is possible to measure fining times with some accuracy if the variables mentioned above are controlled.

Papers 6 to 10 were scheduled for Tuesday afternoon. Of these No. 6, entitled "A Review of Petrographic Work in Glass Technology," by C. G. Harman, Iowa State College, Ames, Iowa, was not presented because neither the author nor his paper could be located. The proceedings therefore opened with Paper No. 7—"Selenium Dioxide as a Constituent of Glasses," by Louis Navias, General Electric Company, Schenectady, N. Y., and John Gallup.

In the endeavor to investigate the properties of glasses having a comparatively low melting point, Dr. Navias found it desirable to examine glasses containing large amounts of selenium dioxide and of tellurium dioxide to which substances no references seem to exist in the literature, except for small amounts in ordinary glasses. Glasses containing large amounts have apparently not previously been investigated. Selenium dioxide melts at about 340° Centrigrade and soon thereafter begins to fume and further is somewhat easily reduced, apparently to the metallic condition. In the process, a white glass turns red. To avoid as many of these difficulties as possible, sodium selenite was used as the raw material and this served in some measure to reduce volatilization and reduction. It became apparent that the oxide was a genuine glass-forming constituent, but most of the glasses formed proved to be unstable to air, scumming and attracting water from the atmosphere. A number of stabilizing oxides were tried and a fairly good glass was obtained containing 10.8 SeO_2 together with soda, lime, boric acid and silica, the last however, to less than 6%.

Paper No. 8—"A New Light-Source for Absorption-Measurements of Glasses in the Ultraviolet" by Willi M. Cohn, Berlin, Germany. Metallic thorium, when bombarded with cathode rays in a vacuum, gives out a blue glow; the spectrum is continuous and extends well into the ultraviolet. It was believed at first that a high vacuum was necessary but it is now found that the glow is obtained in the presence of gases or even of air. The discharge works best at from ½ to 5 thousandths of a millimeter of mercury. In this case, in addition to the blue glow of the continuous spectrum, spectral lines due to the gas also occur. A diagram was exhibited showing the arrangement of the bulb, which contained a thorium anode and a concave aluminum cathode. The spectrum extends from 2,200 to 6,000 AU, with a maximum at 4,500 the infra-red being absent. Spectrographic curves were exhibited obtained with quartz and with glass windows to the bulb. With this new lamp the ultraviolet transmission of iron bearing glasses was determined. With the iron in the ferric condition a minimium occurs at 3,800 AU but this is absent when the iron is in the ferrous state.

Dr. Brown asked how long the lamp lasted, and Dr. Cohn replied that no difference of emission was noticed in several months. The light compares well with that of the quartz mercury for experimental purposes but is of a totally different character. Dr. Cohn stated that the light of the lamp was not polarized.

It was the opinion of the meeting that this paper was of such general interest that its appearance in the *Journal* of the Society should be expedited as much as possible. Dr. Cohn was congratulated upon his mastery of the English language and the Division went on record expressing its appreciation of the presence of a member of the German society devoted to the technology of glass.

Paper No. 9—The Infra-red Absorption of Quartz and its Modifications by Dr. Cohn-Tolksdorf, Berlin, Germany. This paper was not presented at the meeting but will appear in the *Journal* of the Society.

Glasses Suitable for Industrial Eye-Protection

E. L. HETTINGER, WILLSON PRODUCTS COMPANY

Reviewed by Donald E. Sharp

In many cases the presence of iron in a spectacle glass is favorable rather than detrimental because of the increased absorption of ultra-violet. A photo-electric cell may be conveniently used for measurement of the optical density of colored glasses, and for grading into shades. Synthetic glasses are not as yet suitable for eye protective purposes. In the discussion it was brought out that none of the group had ever known of a case of glassworker's cataract, and that from this standpoint the blue glasses containing cerium had no advantages for use around furnaces over the green or brown glasses.

The Strength of Glass as Affected by Casin

BY JAMES BAILEY, BAILEY & SHARP COMPANY

Reviewed by Irving Hyman

Considerable has been written about the strength of glass toughened by chilling the surface, and it has been pointed out that the strength of glass as found by determining its modulus of rupture may be increased to 3.4 times its annealed value by this means. Chilling can only be used on simple shapes and cannot be applied to large surfaces.

The method of accomplishing a similar result by "casing" is not limited by this difficulty. Mr. Bailey attacked the problem theoretically by combining the stress diagrams of that due to the load and to the initial strains set up in a slab by cooling. Equations were derived and a series of curves worked out showing the theoretical relative strength and the initial internal strains to give the best results.

The paper was followed by considerable discussion, the gist of which varied from statements that the indicated results could not be obtained in practice to those of considerable interest in the subject. It was also brought out that the results had not been checked by actual specimens.

Viscosity of Glass Between the Strain Point and Melting Temperature

BY HOWARD R. LILLIE, CORNING GLASS WORKS, CORNING, N. Y.

Reviewed by James Bailey

At high temperatures the glass is mobile enough to be studied with the conventional viscosity measuring devices, but in the region between the softening point and the annealing points the glass is so stiff that data is obtainable with difficulty. It was therefore decided to see if the viscosity formulae could be applied to this region when threads of glass were used as specimens and their viscous elongation under stress used as a measure of the flow.

The glass selected for experiments was a soda lime glass of a composition not subject to devitrification. Glass was made by melting the batch in a platinum crucible, pouring into water and re-melting. It was stirred with a platinum rod to eliminate cords as far as possible. It was then made into the test pieces which were about .6 mm. in diameter and of sufficient length.

These were heated in a carefully insulated electric furnace having a vertical interior core of iron through which the glass fiber hung. The viscous stretching of the glass was measured by means of an optical lever.

Curves showing the data were given. It was found that the conventional viscosity formula applied and that therefore the method described could be used to extend viscosity measurements into the region of glass too stiff for the conventional methods.

Studies on the Etching of Glass

BY W. F. KAHLSON, PITNEY GLASS DIVISION, GENERAL ELECTRIC COMPANY, CLEVELAND, OHIO.

Reviewed by James Bailey

The chemistry and physics of the etching of glass with solutions containing hydrofluoric acid were discussed. Solutions of the acid alone or mixtures with other acids attack glass rapidly, but leave a clear surface. Some evidence of pitting is produced but the surface is generally clear. To produce a mat etched surface ammonium bifluoride must be present. The character of the mat may be varied by additions of ammonium salts. Such surfaces are weak mechanically and must be treated by dissolving off glass so as to round out the sharp edges of the crystal like surface. Photomicrographs of the surface during different stages of etching and curves giving the rate of attack as a function of time were shown.

At the Wednesday Noon Luncheon held in the assembly room, Hotel Hollenden, Dr. G. W. Morey, Geophysical Laboratories, Washington, D. C., gave an illustrated talk on the "Phase Equilibrium System of Na_2O, and CaO, and SiO_2. In addition to the slides, a solid model showing this system as plotted in three dimensions was given. This paper will be given in full in a later edition of THE GLASS INDUSTRY.

Preliminary Discussion of the Flow of Glass Subjected to Strain

BY C. D. SPENCER, GENERAL ELECTRIC CO., CLEVELAND, OHIO

Reviewed by Irving Hyman

Certain published data led the author to believe that actual flow of glass took place at room temperature and might have a bearing on the permanence of strained articles. After considering various methods, it was decided to draw the glass out into threads of small diameter (.06 to .04 mm.) and wind these onto a mandrel. The strain thus set up was very near the breaking point. Mathematical formulae for computing this strain were given. It was found that some specimens broke after a few minutes, others after a few hours and some seemed able to withstand the bending indefinitely. One such thread after remaining on the mandrel for 750 hours was released. It immediately straightened out until the radius of curvature was 17 cm. As time went on the curvature diminished showing that there was a pronounced tendency for the thread to ultimately straighten out but at a very slow rate.

Fibers were floated on mercury to eliminate frictional effects.

The amount of permanent bending varied greatly with the kind of glass used, being much greater in those having the lower annealing points.

The discussion brought out other cases where strained glass had given signs of viscous flow at room temperature.

Stresses in Wire Glass Due to the Wire

BY F. W. PRESTON

Reviewed by James Bailey

Dr. Preston opened the paper by a discussion of the difficulty of interpreting the results of a polariscope study of strains. At first the results did not seem to agree with theory and mathematical computation. Later after all samples were ground and polished the results were found to agree with what might be expected.

The weight of metal being only about 1% of that of the glass the metal might be considered as a thin sheet about 1/1000 inch thick. Under these conditions the metal would contract more than the glass during cooling with the final result that the metal would be stretched slightly and the glass would have approximately 250 lbs. per square inch compressive strain. This would tend to strengthen the glass.

When wire is used, the strains are localized around the mesh points, being tension where the wires open out and compression at opposite places.

The article is illustrated with diagrams, etc.

These wire stresses appear throughout the sheet as small centers of color.

Near the edges an unbalanced condition exists which gives a much larger color pattern when viewed in the polariscope.

The paper is accompanied by a discussion of the proper use of the polariscope and a method of interpreting the observations in terms of numerical values and the general presentation is followed by a mathematical analysis of the problem.

The conclusions follow:

The stress in the wire is approximately at the yield point in tension.

The stress in the glass is approximately 1% of this in compression.

In round figures the wire is strained to 25,000 pounds per square inch and the glass to 250 lbs. per square inch.

(*Additional Reviews on page* 61)

On the Optical Properties of Didymium Glass[1]

By E. J. MOORE,[2] H. S. LEIN,[3] and D. E. SHARP

IN the catalogs of optical glass the different glasses are classified according to their refractive indices and dispersions. The refractive index might be explained as a number which indicates the degree of bending of a ray of light which has struck the glass obliquely. In simple terms the dispersion is the amount by which the glass spreads a beam of white light which has struck the glass obliquely.

Fundamentally the refractive index of a piece of glass is the ratio of the velocity of light of any single color in air to its velocity in the glass. The refractive index of any ordinary material is greater for violet light than for red light. The difference in the refractive indices for any two chosen colors or spectral wavelengths is the number by which physicists designate the dispersion for that spectral region.

The dispersion of a transparent material is generally greater in the violet end of the spectrum than in the red end, and this variation of dispersion decreases regularly. In glass of low refractive index such as crown glasses, the dispersion is lower for a definite spectrum interval than for glasses containing lead oxide. Moreover, all known glasses are similar in having a gradually decreasing refractive index and a gradually decreasing dispersion as one proceeds from the violet end of the spectrum to the red end. However, the fact that the ratio of dispersion to the refractive index of crown glasses is lower than the ratio for the same regions in flint glasses, is the condition which permits us to make achromatic lenses by combining a crown lens with a flint lens. If a glass could be made in which the refractive index and dispersion did not vary in the same direction with change in color of the light, it would result in new designs of lens systems of great utility.

There are some substances having such peculiar refractive index-dispersion ratios. One of these is cyanine, which has an absorption band in the visible spectrum. The refractive index of cyanine gradually decreases from the violet, as wavelength increases, until a region near the absorption band is reached. Here the refractive index commences to decrease very rapidly. On the other side of the absorption band the refractive index is abnormally high and decreases very rapidly for a short region of the spectrum, and then settles down to a much slower gradual decrease just as in any ordinary material.

This phenomenon, which is called anomalous dispersion, is possessed by several substances. It is not confined to absorption bands in the visible, but occurs also in the neighborhood of such bands in the infra-red or ultra-violet portions of the spectrum. It seemed reasonable to suppose that if a glass could be made having a sharp absorption band in the visible, that the glass would exhibit anomalous dispersion. As mentioned above, a glass possessing such properties would be of distinct value in the improvement of lens systems.

The only material known to the authors which could be used in glass for producing a fairly sharp absorption band is didymium. A glass containing this material has a very strong absorption in the yellow, and the curve of light transmission in the visible spectrum is a decidedly irregular one, characterized by several abrupt changes in transmission of which the drop in the yellow is the most marked. It seemed likely therefore that didymium glass might exhibit anomalous dispersion near this band in the yellow, and this investigation was carried out to determine whether or not such anomalous effects existed. Although the results are negative, the data will be of interest if for no other reason than that of saving some other investigator from tackling the same problem in the same way.

The glass selected for study had approximately the following composition:

SiO_2	49.5%
K_2O	14.0%
Na_2O	6.0%
B_2O_3	20.5%
Didymium Oxide	10.0%

The didymium oxide used was a commercial material. It is really not a single oxide but is a mixture predominating in neodymium and praesyodymium oxides but containing also

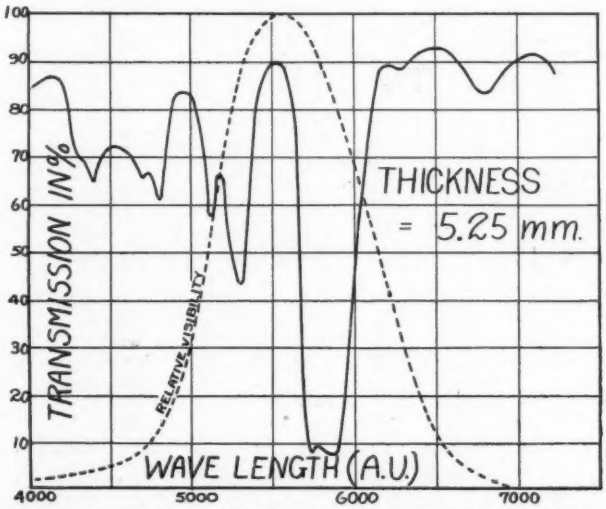


FIG. 1—SPECTRAL TRANSMISSION OF A SAMPLE OF DIDYMIUM GLASS, THICKNESS 5.25 MM.

small quantities of lanthanum and samarium oxides. The spectral transmission of a sample of the glass is shown in Fig. I.

Three methods of attacking the problem were employed:

(1) A dispersion curve was obtained by measurements of refractive indices of a 60 degree prism of didymium glass using an accurate spectrometer.

(2) Another series of measurements of refractive index was made on a 30 degree prism by the use of an Abbe autocollimating spectrometer.

(3) The method of crossed prisms was used as a check.

[1] Prepared from a thesis in partial fulfillment of the requirements for the degree of Master of Arts in Physics, at the University of Buffalo, and in cooperation with the research laboratory of the Bailey & Sharp Company.

[2] Head of Department of Physics, University of Buffalo.

[3] Head of Science Department, Bennett High School, Buffalo.

In method (I), the indices of refraction were found by the usual methods using in turn wavelengths of the copper arc, mercury arc, helium, and hydrogen discharge tubes and the sodium lines. The data is given in Table I. Plotting the refractive indices against wavelength produced a smooth curve with no anomalies.

The second method was used because of the possibility—that a more direct measurement of the dispersions might bring to light differences that would not stand out in the measurements on the 60 degree prism.

The principle of the Abbe autocollimating spectrometer is briefly as follows: when a ray of light entering a 30 degree prism returns upon itself (the back of the prism being silvered) the angle of incidence is the same as the angle of minimum deviation of a 60 degree prism of the same material. Thus the uncertainty ordinarily involved in measuring the angle of minimum deviation for a 60 degree prism is eliminated in the Abbe instrument, and measurements can be made quite rapidly. Moreover, in this instrument a calibrated tangent screw can be employed for measuring the difference in angle for the various spectral lines. Thus the dispersions are obtained very accurately as differences in angle, although the datum level of refraction may not itself be so accurate. The results of the measurements on the Abbe instrument are given in Table II. These refractive indices

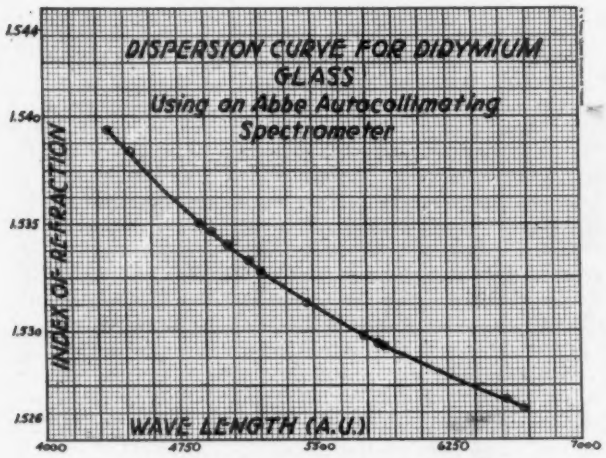


FIG. 2

plotted against wavelength also gave a smooth curve (Fig. 2), indicating that there is no anomalous dispersion.

The method of crossed prisms for detecting anomolous dispersion was also employed as follows:

A widely dispersed spectrum was first formed by the use of a transmission grating (14,500 lines to the inch) fastened on an ordinary spectrometer table mounted with its axis horizontal. This spectrum was then dispersed by a prism of the didymium glass mounted on a second spectrometer with axis vertical. The utmost precautions were used in carrying out these observations. For example, a horizontal slit was placed between the vertical spectrum and the vertical slit of the observing spectroscope.

By looking into the eyepiece of the observing spectroscope, the operator would see a curve of light similar in shape to Fig. 2. The vertical deviation of this curve of light was produced by the refraction of the didymium glass prism, and the horizontal deviation was produced by the transmission grating.

The only evidence of anomalous dispersion was the tendency for the line of light to tail off slightly as the absorption band was approached. The effect was small and may have been due to diffraction. The curve was otherwise charac-

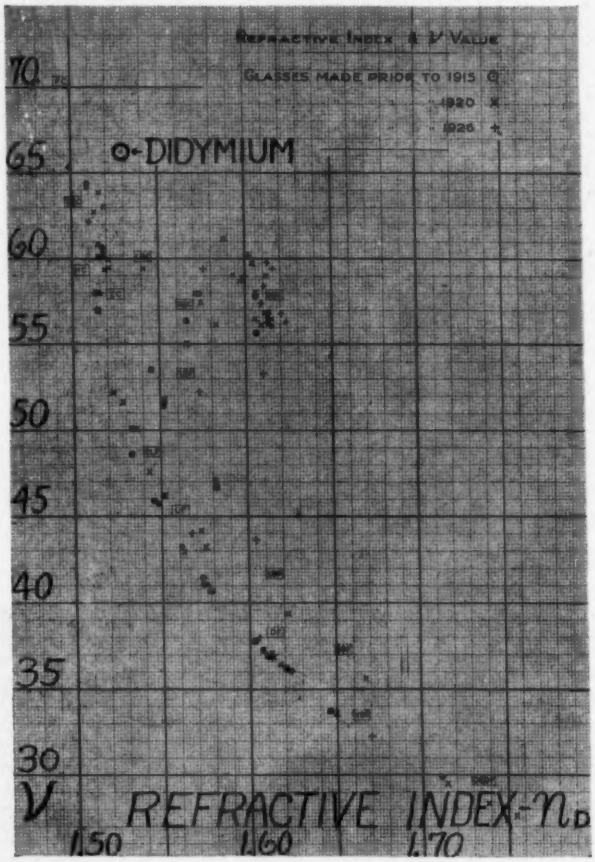


FIG. 3—REPRODUCTION OF A CHART FROM THE CATALOG OF CHANCE BROS. & CO. SHOWING ν PLOTTED AGAINST REFRACTIVE INDEX FOR A NUMBER OF GLASSES

terized only by abrupt "holes" in the spectrum where the absorption bands occurred. It is evident, therefore, that if any anomalous dispersion is present in this glass, it is too small in amount to be determined by the means employed.

One property of the didymium glass which is interesting, and so far as we know has never been noted before, is the high constringence or value of μ. The particular glass on which the measurements were made had a μ value of 66.2 which is quite a little higher than the constringence of an ordinary borosilicate of approximately the same composition, but containing no didymium.

The only glasses which possess as high a value of μ are the phosphate crowns and fluor crowns. Of these the former are not permanent enough to be of much value in optical systems, and the latter are of too low refractive index to be of general utility. The didymium glass has a refractive index of approximately 1.53 which is considerably higher than the refractive index of the fluor crowns. Fig. 3 (from the

catalog of Chance Bros. & Co.) illustrates the difference between the didymium glass and various other optical glasses.

Glasses of high μ and high index, such as the barium crown glasses, are of great value for making highly corrected lens systems. It seems likely, therefore, that the μ value of such barium crown glasses might be raised still further by the substitution of didymium oxide for part of the alumina in the glass. If such glasses were stable, and not too highly colored, they would be useful for many purposes. If, however, in order to make a substantial increase in the μ value of the glass, it became necessary to use so much didymium that the glass became highly colored, the lower total light transmission would overcome all the benefits of the higher μ. These points are being investigated further and will be reported in a subsequent paper.

It is estimated that the measurements of refractive index recorded here are accurate to only a little under plus or minus 4 units in the fifth decimal place. It is obvious that greater accuracy would be advantageous in an attempt to determine definitely the value of such a glass in a lens system.

TABLE I

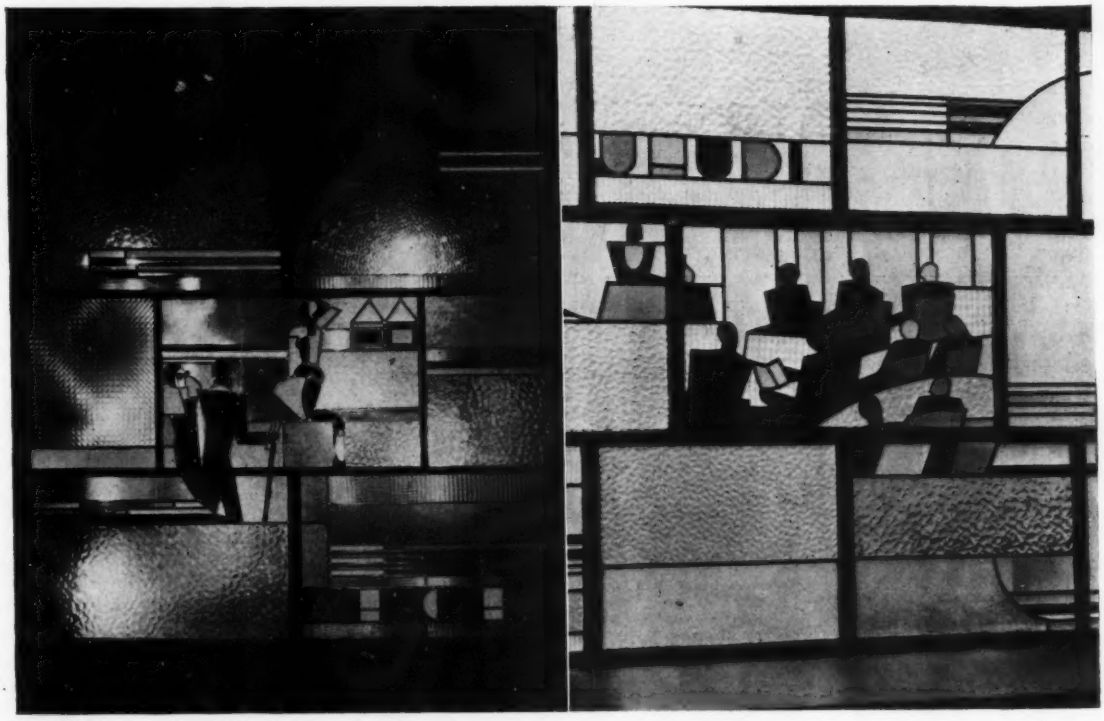
Indices of Refraction of Didymium Glass by Ordinary Spectrometer.

Wave Length (A.U.)	Refractive Index
4046	1.54478
4078	1.54300
4359	1.53948
4471	1.53858
4862	1.53526
4922	1.53512
5015	1.53430
5106	1.53402
5153	1.53342
5218	1.53316
5700	1.53050
5770	1.52990
5782	1.52998
5790	1.52974
5875	1.52956
5893	1.52948
6563	1.52722
6678	1.52694

TABLE II

Indices of Refraction of Didymium Glass (Determined on Abbe Auto Collimating Spectrometer)

Wave Length (A.U.)	Refractive Index
4359	1.53946
4471	1.53843
4862	1.53493
4916	1.53462
4922	1.53460
5015	1.53396
5106	1.53359
5153	1.53320
5218	1.53278
5461	1.53128
5782	1.52975
5875	1.52936
5893	1.52932
6563	1.52693
6678	1.52652



BONNEY

Modern Window Designs in a Paris Newspaper Office

MUSEUM DAY . . . Subject for Wednesday (Mercredi) in the modern window designed by Barillet for the new offices of the Paris publication, "The Week in Paris" . . . of shades on white, grey and black glass supported in frames of forged iron . . . each section of the window represents a different day of the week and each section is included in a different one of the private offices of the building. . . .

"LECTURES," the subject of Thursday (Jeudi) . . . Part of the long modern window designed by Barillet for the new building of the Paris Publication, "The Week in Paris." . . . Each section of the window represents one day of the week. . . . In shades of white, grey and black glass supported in frames of forged iron . . .

The Manufacture of Rolled Plate

By ERNST LUTZ*

(*Continued from the February, 1931, issue*)

This work has been revised, so far as the English and the technical expressions are concerned, by F. W. Preston, who has also added a number of notes relating in general to the special conditions of American practice; but it must be understood that the opinions expressed in the text are those of Mr. Lutz, and neither the Editor nor Dr. Preston accepts responsibility for them.

EVERY time before the sheet is cast, the casting table is covered with the cleanest, thoroughly dried sand or fine glass grains, or a mixture of both, in order to provide an insulating layer between the glass and the cast iron of the table; the lowest glass skin consequently does not chill so quickly, and the plate does not stick; for inserting, the sheet comes more easily off the table and also slides more freely. At the spot where the glass heap, in pouring, falls on the table, the glass grains are blown away. The influence of the insulation layer may be judged from the fact, that the area within which the grains have been removed, is sharply defined and apparent to the eye; in this area the glass becomes at once darker and cooler than in the immediate neighborhood. On no account, however, must there be any combustible organic dust and the like on the table; in rolling the glass over it, these impurities would burn, and their combustion gases would appear as small bubbles and seeds in the glass sheet. The table has to be kept free also of any humidity, as the vapor would cause humps in the sheet; for the same reason care has to be taken that no oil from the casting crane drops on to the table. On a new casting table, and on such as have not been used for a certain time, the first sheet produced gets heavy humps simply from the moisture, which has gathered in the pores of the cast iron; up to ten and even more sheets have to be rolled on the table before all the humidity is dissipated.

In order to prevent small bits of clay from falling off

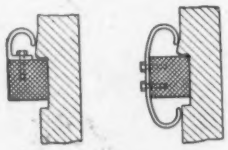


FIG. 81

from the pot, due to the pressure of the casting scissors, into the glass mass, in some factories the scissor-shank over which the tipping is done, is fitted with a catcher of ring form, as shown in Fig. 81, and which collects any stray clay pieces. This catcher however has the disadvantage of also gathering dirt and dust particles which cannot be easily brushed away and therefore may fall in the glass when tipping the pot; with tongs handling the insertion and the withdrawal of the pots from the furnaces as well as the teeming, the said catchers soon get burned in the manoeuvring of the tongs in the furnaces.

The realization of a sheet thickness which is equal all over, is very important for efficient working in the grinding shop; the more uniform the thickness and the planer the rough glass sheet, the quicker the grinding and the greater the output and the smaller the breakage in the grinding shop; with it at the same time the output of the whole glass works increases and the expenses in wages and materials decrease. The less the rough glass sheet has to be ground off, i.e., the less rough glass is required for the finished plate glass sheet, the less batch material and the less fuel is required in the furnaces. Today, since the introduction of the stationary water cooled casting table and the heavy well-cooled rolls, the thickness of ordinary rough glass sheets varies between .395 and .435″, sometimes also between .375 and .415″, whilst formerly the range was .420 to .550″. The planer the rough glass sheet, the less has to be ground off on either side; if therefore the flatness of sheets produced in the rough glass factory is very good, their thickness can be so much kept down, that it is just possible to remove the rolled sheet in time into the lehr. The thinner the sheet is rolled, the quicker, naturally its head, i.e., the first rolled part of the sheet, cools, and consequently the quicker the rolling has to take place, to prevent the head from distorting and cracking before the rest of the sheet has become sufficiently strong to stand the strain of the stowing. The flatness of the sheets depends mainly on the conditions obtaining in the lehr, the uniform sheet thickness, however, depends exclusively on the equipment and the work of rolling.

The trams which primarily fix the thickness of the glass must lie tightly on the table and be themselves of uniform thickness; formerly rods were used which at their head and for a length of 3′ to 7′ were somewhat thicker than the remainder, so that the head of the rough glass sheet was intentionally made thicker than the rest of it. This expedient was used in an attempt to keep the sheet head warm as long as possible so that no cracks should form prior to its insertion in the lehr; this was necessary, because in comparison with present day practice, the end of the rough glass sheet itself was relatively strong, and it took quite a time after the rolling until it got the necessary rigidity for being pushed into the lehr; with the old single chamber annealing kilns it was furthermore rather difficult to maintain with certainty at the kiln end, where the sheet head was located, the temperature required to reheat the head to such a degree, that it became flush with the horizontal bottom of the kiln. Today as mentioned before, "trams" are used, which are of constant thickness throughout; they are made of steel and must be sufficiently strong to carry, without any deformation, the full

* Of Desseau, Germany. This work will appear in German in the forthcoming new edition of *Dralle-Keppeler*, "Die Glasfabrikation," due this year, about July. The GLASS INDUSTRY probably will by that time have completed the English translation, with some comments on its applicability to American conditions by F. W. Preston.

FOOTNOTE: In the Figures, originally prepared for use eventually in the coming new edition in the German language of *Dralle-Keppeler*, "Die Glasfabrikation" in 1931, dimensions are given in metres (*m*) and millimetres (*mm*). We would like to have given these in feet and inches but the translation and the making of nearly two hundred and fifty new illustrations would have involved a prohibitive loss of time and expense. To some of our readers the metric system is as familiar as the English units; for the others we may say that a metre is approximately 40 inches, and a millimetre is approximately 1/25 of an inch. A thousand millimetres, of course, go to a metre.—*F. W. P.*

weight of the roll when returning from the roll winch. If the trams in their rough state should not be of uniform thickness they have to be planed.

For the fixing of the rough glass sheet thickness, rings were formerly used in place of the planing rods. These were either shrunk on the roll ends or machined thereon; such rings are still met with in plants for ornamental wire-, and the like, rough-glass. Such rolls progress in the horizontal direction at a rate given by the ring diameter and not by the roll diameter. After one complete turn the roll has moved forwards by a distance which is somewhat greater than its periphery, its movement is thus composed of both rolling and sliding and the glassheap accordingly is not only rolled down but also pushed forward. The smaller the difference between ring- and roll-diameter the smaller will be the sliding component. With the usual sheet thickness no perceptible drawbacks arise, but the desirability of using the same roll for various sheet thicknesses and sheet widths prevented the adoption of such runner rings and today planing rods are exclusively used for the rolling of rough plate.

During the rolling, the pressure of the roll on the planing rods is but small on account of the lifting effect of the glass mass; great care must therefore to be taken that the rods are free from dirt, sand and the like, as by reason of the floating effect the roll follows the least irregularities of the rods, causing at the same time variations in the sheet thickness. It is also essential that the guns should not permit any glass to pass, as otherwise it will reach the trams, causing again an unevenness in the rough glass sheet.

The roll has to be of such weight that it touches the trams constantly and does not, as in old-time practice, swim on the glass. As mentioned before, the top layers of the glass in the pot, which are stiffer than the rest, in teeming fall first and immediately beneath the roll; they will therefore form the head of the glass sheet; now the more viscous the glass, the greater the possibility of the roll's floating. The roll must evidently be heavy enough to overcome this even at the beginning of the rolling, i.e., at the head of the sheet and actually rest on the trams. For the production of a rough sheet of uniform thickness it would be preferable to use, for casting, a glass of greater fluidity than is actually done, but, as pointed out before, a certain degree of viscosity has to be adhered to, as otherwise the glass in pouring out will flow turbulently towards the roll and disperse like thin pulp. Such a thin glass mass would get full of air bubbles and would entrap and become contaminated by the combustion gases of all the dust coming into contact with it, whilst with the stiffer glass this will not happen. Even with all cleanliness the presence in the rough glass shops of much combustible dust cannot be avoided. Finally, too liquid a glass would easily squeeze out between guns and roll.

Formerly rolls of 15″ to 20″ diameter were generally used; they were hollow and had a wall thickness of 3 to 4″. With a length of 16½′, inclusive of the shaft they weighed 11,000 to 14,000 lbs. This weight is not sufficient to squeeze the glass mass down to the thickness of the trams; this is shown by the fact that during rolling, feelers of .020″ and even more can freely be inserted between roll and tram; in consequence the rough sheets always got appreciably thicker than the planing rods. The rolls were kept hollow in order that they could be air-cooled and also because the hollow roll, when distorted through uneven heating up, will straighten out again more quickly than the solid one. Hollow rolls must be turned on both their inner and outer surfaces, so as to have everywhere the same wall thickness; rolls of unequal thickness are quite erratic in their behavior against heat, and the precautionary measures adopted to protect them from distortion due to unequal heating are more difficult than with rolls of equal wall thickness. Today rolls generally have a diameter of 23½″ to 26″ and, with a length of 16½ to 18′, attain a weight of 20,000 to 23,000 lbs.

A greater diameter increases of course the surface of the roll on which the upward thrust of the glass is acting. It is none the less possible to realize a higher specific pressure of the roll on the glass and this all the more, as the roll walls can be made appreciably stronger and the shaft be fitted with a core, increasing its weight, but leaving a hollow space of annular form, through which cold air can circulate. Water-cooled rolls are provided with a core, which only leaves channels for the circulation of the cooling water. With very stiff glass even these rolls do not suffice to press the glass completely down to the thickness of the planing rods, particularly if the sheet is relatively thin, i.e., below ⅜″; even in these cases, however, it is an exception for the rolls to actually swim and not touch the planing rods, whilst this state of affairs was the rule in earlier times.

Of direct influence on the glass thickness is the behavior of both roll and casting table under the influence of heat; after teeming out, the glass mass for a moment leans upon the roll at rest, until the latter is drawn by the rope and starts to turn. Now the side of the roll at rest, which is for quite a while in contact with the hot glass, expands appreciably, whilst the opposite side remains cold; the roll therefore must distort, and curve towards the glassheap. The casting table is subjected to similar deformations; its surface in contact with the glass will expand whilst the opposite face remains cold. The table therefore will crown upwards; its curvature lengthwise, in contrast to that crosswise, is of no influence on the glass thickness.

The expansion of the roll and casting table is illustrated exaggeratedly in Figs. 82 and 83. Due to the curvature

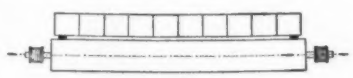


FIG. 82

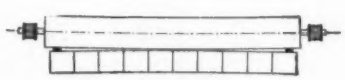


FIG. 83

of the table, the sheet will become thinner in the middle than towards the edges. This effect is still more pronounced at those places where the bowed part of the roll is at its lowest position. Usually the deformation of the table is not so great as that of the roll, so that at the spots where the hollow side of the roll faces the table, the sheet will get *thicker* in its middle than at the edges. Appreciable variations in the thickness of the sheet may thus arise. Now if for the next sheet the glassheap should

again be poured on the same side of the roll, the deformation would increase continually; care has therefore to be taken that from sheet to sheet the initial position of the roll is so changed, that its side in contact with the glassheap lies away from it on the next cast, and the deformations alternately balance each other; for this purpose the head of the roll is marked with a sign, perhaps with a chalk and care is taken that this sign is alternately in front and at the back.

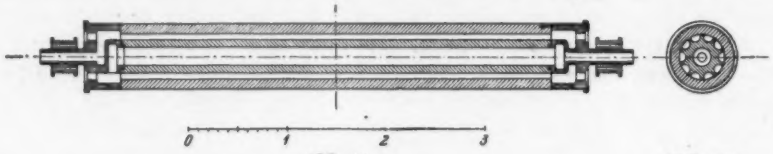


FIG. 84

Experience has however shown that in spite of all these measures, the unevenness of the subsequently rolled sheets becomes more marked than in the first rolled ones. For this reason it has become the usual practice to change the roll completely after every second or third sheet.* In old glass factories with single chamber annealing kilns on each side of the casting table, as for example illustrated in Fig. 60, this change of rolls is only natural, as in this case each side of the hall has its own roll. These are naturally alternated, as only one or two or at the most those sheets are rolled in succession towards one side, whilst the next or the next two to three sheets are rolled towards the other side. With stationary casting tables, water cooled rolls as shown in Figs. 84 and 85 are used, where the heat is quickly carried away by the cooling water.

The cooled core exerts a restraining effect on the deformation of the shrunk-on cylinder. As soon as the sheet is stowed into the annealing oven, the roll is returned with all possible speed to its initial position at the head of the table, where it is coupled up with the water inlet and exit pipes. Immediately before the pouring of the next pot, these tubes are unscrewed again. In between these operations the roll is filled up with water, which, thanks to automatically operating valves, will remain even after the tubes have been taken away. The longer the cooling water is passed, the less will the roll at rest be distorted by the glass heap leaning against it. The tubes of course have to be protected from contact with the hot glass. At the ends of the roll removable access-doors are provided, so that the channels can be cleaned of dirt and other sediments.

Instead of using the water-cooled roll, many factories prefer four to eight hollow rolls which are used in turn, so that any one of them is only in service for four sheets in succession at the outside. For this purpose two trucks are provided at the head end of the table (see Fig. 62) of which one serves to remove the roll which has just been in use and the other to fetch the next one. The rolls which are not in commission in the intervals can be put on roller supports and be kept turning by an electro motor, whilst cooling water is running over their inner surface. If not prevented by the casting crane, overhead bridge cranes or trolleys may also be used in place of the truck for changing the rolls.

The water-cooling of modern casting-tables as shown in Figs. 62 to 65 can be so regulated, that the tables, even after the casting and rolling of any number of sheets, hardly distort at all crossways. On such tables, and with the aid of water-cooled rolls or rolls which are changed frequently enough, a fairly thorough evenness of the sheets can be attained, so that in one and the same sheet differences of thickness of rarely more than .040" arise, whilst with tables as shown in Figs. 57 to 59 (which at the time represented great progress), differences up to ⅛" had to be contended with.

FIG. 85

These latter tables are likewise built up of segments, but due to the one-sided heating up, fairly appreciable distortions will be produced over the full table width because the segments have to be pressed together by stay bolts, leaving no clearance between them; this table, in respect of crosswise distortion therefore behaves similarly to a solid iron plate. It has however the advantage of not getting permanently warped, as the individual segments, in cooling down, reassume their original form more easily than a broad plate. Irregularities in the position of the various segments can, up to a certain point, be compensated by the insertion of fine sheet strips or shims at those places where the segments are in contact with the traveling frame.

The stay bolts should be pulled up only to such an extent, that there are no clearances between the segments, because the more forcibly they are pressed together, the worse will be the crosswise distortion. If, in the cold condition, a clearance of such magnitude is tolerated that the expansion of the upper layers of the table just close it up, then the distortion will be decreased. The adherence to such clearances with the cold table, in some cases has been so effected that the inner segments at their sides have been planed somewhat hollow, as is shown exaggeratedly in Fig. 86. The reflection on which this measure was based was this: the segments in the middle, i.e., at half the length

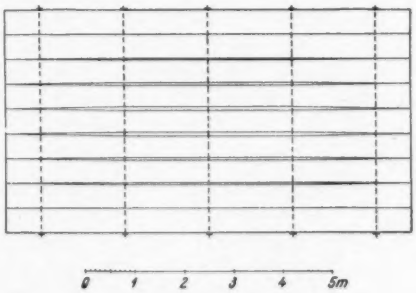


FIG. 86

of the table, expand the most, because at this place relatively hot glass remains fairly long before the sheet is removed, and also because the middle of the table does not cool down so rapidly as its ends; it is a fact that the curvature crosswise is greater at the table middle than at its head in spite of the fact that, during the tipping of the pot and the stay of the glass heap on the table, more heat gathers at this place than any-

* America did not reach this stage of refinement. F. W. P.

where else. However, as mentioned before, when pouring out, the top layer, that is to say the coldest layer of the pot content, gets to the bottom and congeals relatively quickly; it is very likely that this layer protects the head of the table from being excessively heated up by the glassheap. The main reason for the crosswise deformation in the middle

FIG. 87

being the greatest is, however, the fact, that the lengthway deformation in the middle segments is also greater than in the outer ones (Fig. 87). The ends of the middle segments therefore stand somewhat lower than those of the outer ones,

FIG. 88

so the crosswise deformation at both table ends is more or less equalized whilst in the middle the lengthwise deformation, on the contrary, increases the crosswise deformation. This was particularly well revealed with tables of older design and without cross keys (as shown in Fig. 88 for example).

The cross stay bolts oppose the differences in lengthwise curvature of the various segments and thus help to reduce the combined curvature in the middle of the table. They also prevent individual segments, on account of smaller or greater lengthway deformations from separating from their

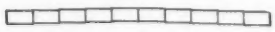


FIG. 89

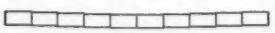


FIG. 90

neighbors, so that a condition in the table middle as shown in Fig. 89, or at the table end as shown in Fig. 90, cannot arise, and the edges of the segments do not protrude appreciably.

Any slackening off of the cross stay bolts, so that with the cold table clearances exist between the various segments, is rather dangerous, and in any case must be carried out with great care, i.e., the clearances must only be very fine and must run evenly over the whole table width, as otherwise in spite of the slackening off of the stay bolts, the majority of the segments remain tightly together and the whole clearance is taken up by one or two segments only, which would then come so much apart from each other that during rolling, glass would be squeezed into the gap. This of course would happen with the first sheets rolled, when the expansion of the table has not yet gone sufficiently far, to close these fissures. But even the smallest clearances will gather dirt, sand and glass particles, which will prevent their complete closing up. The main danger is now, that the edges of the segments, due to jammed foreign matter, may get pitted, and the glass get rolled into the cavities; furthermore, the edges of the segments along the clearances soon wear off, which causes the formation of ribs on the under side of the glass sheet. Due to these protuberances and ribs the sheet will offer a greater resistance to stowing, which again increases the likelihood of jamming; however what is more serious, is the fact that, due to these imperfections, the sheet is no longer able to come into complete contact with the bottom of the annealing kilns; over each protuberance and over each rib a hump will form, as shown in Fig. 91, causing heavy losses of time in grinding or the entire destruction of the sheet; bumps of greater magnitude must be cut out of the sheet, which, of course, means production loss; instead of large sheets a number of smaller ones are obtained which are less valuable than a single larger one.

Injuries to the surface of the table as well as to the roll

FIG. 91

have the further drawback of collecting dirt which burns, the combustion gases penetrating into the glass. As soon as the table shows perceptible pitting and wear of edges, one is forced to plane the segments anew. The possible dangers which have just been pointed out show that any slackening of the cross stay bolts, as well as a table design as shown in Fig. 86 is questionable in its efficiency.

It has further been suggested that one might machine the top of each individual segment, so that when cold, the table is slightly concave (Fig. 92) and its surface when the upper

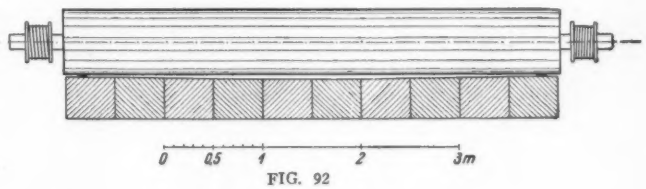


FIG. 92

layers expand, approaches the perfect plane. It is quite practicable to machine the segments so as actually to obtain the said form of the table; however, its behavior under the influence of the heat cannot be controlled sufficiently accurately so as to compensate with certainty the effect of such small changes, the more so with movable tables, the surface of which also suffers from the inequalities of the rails. The stationary modern tables and their combination with lehrs, and the water cooling of table as well as roll, reduce, as mentioned before, the drawback of the onesided heating up of table and roll; however to some extent the conditions and circumstances pointed out still prevail in this more modern machinery.

The thickness of the rough glass sheet is further influenced by the wear of tables and rolls caused by the trams (see Fig. 93). The cavities in the table and the wear of the roll on its running surface gradually increase, so that the two outer table segments must from time to time be planed; to avoid in these intervals any shutting down of the plant, two spare segments have to be kept at hand which can replace the worn ones at any time. The rolls themselves have also to be turned clean from time to time and, as will be seen later, this is necessary for another reason. As illustrated in Fig. 84, the ends of modern rolls consist of cast steel, bolted to the center part. Cast steel is employed to reduce the wear caused by the trams. If the hollows worn in table and roll are left to develop too much, control over the thickness of the glass is lost.

It is also observed that generally the wear is not uniform over the full length of the table and is also unequal on the two sides. This again causes variations in the thickness of the sheet, but above all these discrepancies arise through the fact, that the form of the wear in table and roll is arc-shaped. If it happens that the tram is at the lowest point of such a hollow, i.e., at x in Fig 93 the glass thickness will become smaller than if the planing rod is placed at z or at y; in practice it cannot be arranged, that the tram is always in the same position; the pressure which the glassheap, on account of the load of the roll, exerts on the gun, frequently displaces the trams more or less.

The wear of the table could be somewhat counteracted if the tram were let into the table till only the desired thickness is standing proud of it; the drawback of such an arrangement would however be the fact, that once and for all a certain width only of the sheet could be manufactured on this table. One likes, however, to keep a free hand as regards the width of the sheet to be rolled, and rather faces a certain wear of the outer table segments.

These two outer segments are exposed to a further source of deformation. When the roll is returning from the sloped plane of the roll winch, its whole weight will more or less hit the ends of the two outermost segments of the table. This happens at the place where winch and table meet. In order to protect roll and table somewhat and to reduce the shock, soft wood or better, thick strips of felt are inserted for the moment when the roll passes. With modern tables, the segments of which have a height of over 16″, it is hardly likely that the segments will be perceptibly bent downwards by the sudden impact with the roll. On the other hand, with tables of old design and segments of only about half the above mentioned height, it was observed that the ends of the two outermost segments facing the roll winch were bent downwards appreciably and in time showed permanent deflection which increased more and more; this of course entirely changed the thickness of the sheet at this end.

When congealing on the casting table, the rough glass

FIG. 94

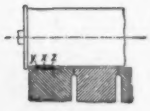


FIG. 93

FIG. 95

sheets get wavy and the waves are so short that they do not disappear in the lehr. The direction of the waves coincides with that of the rolling, i.e., the wave peaks and the wave valleys go parallel to the longitudinal direction of the sheet (see Figs. 94 and 95). These waves will be the higher the thinner the sheet is rolled; with thick sheets, i.e., from about 5/8″ thickness and upwards, the waves are hardly noticeable. They are a drawback in the grinding of the sheet; with thicknesses of 3/8 to 7/16″ the difference in level between wave peaks and wave valleys may amount to .080″ and more. It has been found that these waves become appreciably weaker or do not arise at all, if the roller is rippled, the magnitude of the waves decreasing with the depth of the rippling. The rippling however is pressed into the surface of the sheet and renders the cutting of the finished sheet more difficult. For this reason the rippling of the rollers is only made of such depth that the plate can be cut with certainty; this is the case with a depth of rippling of about .030″. The effect of the rippling is such, that today in sheets of 3/8 to 7/16″ thickness the waves are but very small and hardly perceptible; smooth rolls are no longer used.

It was further discovered that it does not matter, whether the rippling goes parallel to the axis of the roll or crosswise to it (Figs. 96 and 97) or whether it runs in a spiral line (Fig. 98). Opinions differ as to which way of rippling should be given preference; it is, however, mostly agreed that

FIG. 96

FIG. 97

FIG. 98

lengthwise rippling as shown in Fig. 96, prevents the formation of waves most efficiently; on the other hand, however, this arrangement facilitates the rolling of dirt into the sheet, whilst with a cross rippling as shown in Fig. 97, this is less likely; this latter type can also be produced more easily.

The rippling wears off in time, and depending on the use of the roll, has to be renewed every ½ to 1½ years. Also it must not extend to the roll ends, as otherwise the wear on the running surface of the planing rods would be very much accelerated.

The formation of waves would be further reduced and the evenness of the sheet still more perfected, if the surface of the table were ribbed in a similar way. The rippling of the table, however, would render the insertion of the sheet into the lehr appreciably more difficult, and the ripples on the under side of the rough sheet would cause heavy wear of the bottom of the lehr. The strongest objection, however, is that the ripples of the table would gather dirt and dust, causing imperfections in the sheet. For these various reasons the rippling of the casting table has not been adopted up to the present.

The uniform thickness and the flatness of the sheet are strongly influenced by the ratio of the diameters of the roll to that of the rope drums fixed on the ends of the roller axis, from which the rope pulling the roll is paid off during rolling. Formerly these drums were not used at all, the end of the rope being simply fixed with a hook or thimble on to the roller axis (Figs. 59 and 99). However, with this arrangement the roll very frequently did not turn at all and the glass heap was consequently not rolled out, but simply pushed flat. When not turning, the roll follows more easily the varying upward thrust of the glassheap and also the resistance originating from the guns; as long as the

trams are touched, the roll slides instead of turning, and this increases its tendency to rise from the trams and to float, particularly so if the trams are covered with sand grains and small foreign matter. The roll that slides instead of rolling, also exerts a pull on the glass, which manifests itself mostly at the spot where the sheet just rolled, but still soft, connects with the glassheap; it was discovered that this circumstance increases the formation of length waves, which as mentioned before, arise during setting.

Furthermore, the roller, as long as it is not turned, is also unequally exposed to the heat. From the aforesaid it is evident, that if the roll is not turned, but simply pulled over the glass, then the uniformity of the glass thickness and the flatness of its surface will be curtailed in various ways, and this the more, the stiffer the glass and the lighter the roll.

The arrow W in Fig. 99 may represent the average resultant force of all resistances in the horizontal plane opposing the movement of the roll. If the roll, on account of the pull Z of the rope acting immediately on the axis, does not turn, the lever arm a and with it, the turning moment $Z \times a$ is not sufficient to overcome those resistances opposing the turning of the roll; these resistances originate mainly from the friction of the roll surface on the glassheap and the guns; the first one is increased if the roll is fitted with length-rippling. If all these resistances are concentrated in the force T and if the radius of the roll is called r, then the roll with slide as long as $T \times r$ is greater than $Z \times a$; the roll on the other hand will turn as soon as $Z \times a$ is greater

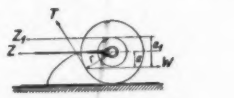


FIG. 99

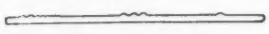


FIG. 100

than $T \times r$. The greater a, the greater will be $Z \times a$; the position of W being fixed, a could only be made greater by upwards extension, i.e., the rope drums must be put on the axis and the roll ropes must unwind on the top. In this way it is possible to make $Z_1 \times a_1$ greater than $T \times r$.

The diameter of these rope drums, however, should not exceed a certain limit, because experience has shown that the roll will not move forward as quickly (as given by the rectified length of rope), as soon as the diameter of the rope drums passes the said limit; in this case the forward movement of the roll during one complete revolution, does not correspond to its periphery, i.e., it turns more or less on the spot. This causes the formation of rather strong cross-waves on the rough glass sheet, which are very bothersome in grinding; however, these waves do not penetrate the sheet like the length waves mentioned before, but are simply accumulations of glass on the upper surface of the sheet (Fig. 100) caused by the dwelling of the roll. The glass at these spots will set very quickly, and more quickly than the sheet immediately on the other side of the roll, as the iron of the roll carries the heat away more easily than the air; very unfavorable stresses are thus produced in the sheet, which do not always disappear in the lehr. Such spots of accelerated congelation, after the further rolling, and until the insertion in the lehr, are noticeable as dark stripes running across the rough glass sheet.

The heavier the roll and the more positive its pressure on the trams, the less will be its inclination to turn on the spot. With the rolls at present preferred, i.e., of 23 to 26″ diameter, and 20,000 to 22,000 lbs. total weight, the rope drums on the roller axis are given a diameter of about half the roll diameter. With this ratio the best results have been obtained. As soon as the diameter of the rope drums is made greater, the idle turning on the spot is noted.

If for example, in the initial position of the roll, a chalk mark is made at the lowest point of its end, and another immediately below it on the casting table, and if a new chalk mark is made on the table to register with the chalk mark on the roll each time the mark is in its lowest position, then with a regular turning of the roll, the distances between two chalk marks on the table should be equal to the periphery of the roll. If this distance between two marks is greater than the periphery, the roll evidently has at times been pulled without turning; if on the other hand the distance is smaller, the roll at times has turned idly on the spot.

The turning of the roll on the spot also increases the time taken for rolling, in an undesirable way, so that the head of the sheet gets even colder than usual. If required, to counteract such interruptions, the velocity of the roll must be increased towards the end of the table, bringing the drum motor to its highest speed. As stated before, the roll is generally given a velocity of about 10″ per second. If the velocity is chosen too high, the tendency of the roll to float and to turn on the spot is increased; sufficient time must be given for the glass at each place to be pressed down to the thickness of the trams. The core of the glassheap, i.e., its hottest part, supplies the end of the rough glass sheet; now as this core keeps its temperature and softness up to the end without any appreciable loss, it is possible to accelerate the movement of the roll towards the last.

With an average velocity of the roll of 10″ per second, i.e., 600″ per minute, with a roll diameter of say 26″ and a diameter of the rope drums of 13″, each of the two drums of the roller winch has to wind up $600\ (1 + 13/26) = 900''$ $= 75$ feet of rope per minute. This fixes the revolutions of the roll winch drums and the gear ratio between motor and drums.

In order to prevent the sliding of the roll and its turning on the spot, both sides of the table might be provided with a rack, in which two pinions sitting on the roller axis engage. By this measure the roll would be forced to a continuous rolling. The pitch diameter of the pinions would have to be accurately equal to the diameter of the roll. However, the racks might catch some of the glass brushed off the table with the ladle, and if the teeth of pinion and rack do not engage without any shock whatsoever, the roll will vibrate, again causing inequalities on the surface of the sheet. The perfect engaging of pinion and rack would also be hindered by the distortions of table and roll. Such constraint guides for the roll have therefore not yet been adopted in the manufacture of plate glass.*

(To be continued)

* They are in use successfully enough in American wire-glass practice.—F.W.P.

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Underconsumption

Our malady has been diagnosed as underconsumption. The public has to be encouraged to consume more. Our women have been dieting, and so ruining the farmer. Our men have been too industrious and have at last caught up with the ability of their wives to spend their incomes, so now there is a surplus of everything and nobody to consume it. Again it is the women's fault. There ought to be hordes of non-producing, highly consuming, children, and not so many grownups, all economizing on their meals, neglecting to wear out their pants-knees, shoe-leather and the household furniture.

We are out of work, and broke. And all because we do not have enough consumers. We are all parasites on the community, useless producers; we have committed the crime of working. We have been industrious, which is not what the country wants. What is worse, we have been thrifty. As a nation, we have built up enormous bank deposits. It is an unpardonable sin. We should have spent our money as fast as it came in, preferably on liquor, for this would have incapacitated us on Mondays, and reduced our weekly production. And we should have had larger families, so that with less earned there would have been more to keep. Then consumption could have gone ahead, and everybody been poor and happy.

It is time that a little scientific attention was given to the industrial and financial structure of the nation. The subject is regarded as particularly holy, and not to be tampered with. Our government is the best in the world—witness Chicago. To question it were treason and deadly sin. Our capitalist system is wonderful and beautiful, and provides us with magnificent and exciting spectacles in Florida land-booms and stock market crashes. No better scheme could be devised.

Progress must be achieved by evolution, or better expressed, gradually, a step at a time. But it is none the less foolish to put off the taking of a step when the time is ripe.

Our social structure, though fundamentally the same, is changing sufficiently rapidly to need modified practices to make it workable. It seems, to a casual observer at least, that since families are becoming small (a very desirable thing from many points of view) and the proportion of children is a community therefore less, we are arriving at a state of society where a greater proportion of the people are producers than was formerly the case. This must tend to overproduction quite apart from the effects of mechanical invention and labor-saving machinery.

Further, unmarried women are almost universally anxious to get into business or employment of some kind, and this would again tend to increase the producers. Perhaps the great bulk of unmarried women always were producers on no insignificant scale, so the effect here is not easily assessable.

Moreover the number of married women in industry is probably higher today than ever, for they are not so tied down at home by their families.

If we are all to be producers, in accordance with the present trend of social development, it seems clear that certain amendments to our social constitution must follow.

Somehow or other we must have an essentially consuming element. If it is not to be the children, it must be the old folks. We are headed toward a situation where it is desirable that the bulk of men and women above 45 or 50, if they have put in twenty years or so of honest work, should be entitled to retirement in reasonable comfort, appropriate to their education and needs, if they so desire. There are plenty of men below the half century mark to do all the producing that is reasonably necessary in the modern world.

And it is far better, from a social standpoint, to get the young bloods to work as soon as they are through school, than to keep the noses of the aged, or even the aging, on the grindstone. The older folks are less likely to paint the town red.—*F. W. P.*

The Devil's Own Number

It would probably have been a good thing for the human race if man had had eight toes like a bird instead of ten like a monkey. For his ten fingers and ten toes resulted in his inventing the decimal system, which is fundamentally bad and unfortunate, though it has been developed to a point where it has served us very well indeed.

If he had descended from the feathered instead of the furred inhabitants of the tree tops, and had had eight toes, he would have invented the octaval system, where the number 11, instead of meaning one-ten plus one, would have meant one eight plus one, or what we now call nine.

It might be profitable to see if this system would be a good one. The average mechanic measures his inches in eighths, sixteenths, thirty-secondths and sixty-fourths. This tendency to divide by two, taking one-half of anything as the next smaller unit, is psychologically sound. There is nothing more fundamentally human than this. Yet it requires a moment's thought, or some practice, to decide whether 23/64 is greater or less than 3/8. So the scientifically minded elaborated the decimal system and decided the point by examining whether .359375 is greater or less than .375000. The remedy is worse than the disease.

If, however, we used an octaval system, then 23/64 would be written 27/100 and 3/8 would be 3/10 or 30/100, and it is immediately evident that 23/64 is 1/64 in our present notation (or 1/100 in the octaval notation) less than 3/8.

The remedy of the scientist is to decide that sixty-fourths of an inch are foolish and the inch should be divided into a hundred (or one thousand) parts; and this is done in the modern micrometer, and works well enough (just as well as centimeters and millimeters anyhow). Only it is not psychologically sound, even to the descendants of monkeys.

You may prove this by trying to cut a pie into ten equal parts. The strain on the nervous system is terrible. There is only one worse undertaking and that is to divide it into eleven. Not all the mathematicians of the Sorbonne could make a job of that, and most of them would fail pitifully in dividing it into ten. It needs a conjurer even for that. But anyone can divide it accurately into eight, sixteen, or thirty-two (if the family is as large as that) by first dividing it into two and four.

The tendency to divide things into twos may be seen in the American coinage. Having decided to decimalize it, we create a dollar, a half dollar and a quarter. They are not described as 50 cent or 25 cent pieces as you may see by examining the coins in your pocket. The human mind has no use for fives and tens; it is interested only in twos and halves. Even the quarter is "two bits."

The highly abstract system of decimalization, or working in tens, is thus seen to be unnatural, and purely intellectual. It does not correspond with human emotions, desires, or nature.

Primitive man came upon a lion in the plains. He had a vivid sensation. Not so much the idea of a "lion" as, "it will eat me." He kept his eye on the lion. Then he became aware of another lion behind him. That was another sensation. The difference between one lion and two is profound; for you can keep your eye on one, and you cannot keep it on two. The addition of further lions makes little difference; three or four is just a plurality of lions (as the patent agent would say), the same as two. Any excess of lions beyond one is "plenty," or a "lot"; too many in fact. The African savage still figures that way. "Maningi" or "Mingi" (many) can apply to any number from two upwards.

There is a third sensation, which is not quite so vivid, and is not realized so spontaneously, viz., the total absence of lions, or the idea of "none." These three concepts, none, one, and two are fundamental and correspond to human nature. Ten is an impossibly complex idea.

Thus our natural system would be:—O (none), 1 (one), 10 (two), 11 (three), 100 (four) 101 (five) 110 six) 111 (seven) 1,000 (eight), and so on, using no digits other than 1 and 0. To multiply by two, you stick an O on the end, and to divide by two you knock it off.

The disadvantage of the system is that relatively small numbers need a lot of digits to express them. Thus 64 would become 1,000,000, and twenty-three ($= 16 + 4 + 2 + 1 = 2^4 + 2^2 + 2 + 1$) becomes 10111, so that 23/64 is .010111.

This is cumbersome and the octaval system is better.

In either system the logic of "sixteen pennyweights one ounce, sixteen ounces one pound" is apparent.

. . .

There is another system which seems to have taken hold of European countries, viz., the dozen. When the French started to tinker with measurements and proposed to discard inches and pounds, they were beaten when it came to tinkering with time. The day still has twelve hours in spite of the French revolution, and the hour is divided into 12 sets of five minutes and the minute into five dozen seconds.

The day is not the only thing that is divided into twelves. Bottles and other commodities are sold by the dozen and the gross. The foot is divided into twelve inches on dry land and at sea the fathom is half a dozen feet. The circle is divided into three hundred and sixty degrees, not 350 or even 400. Many of these measures (60 minutes to the hour, 360 degrees to the circle) show a double allegiance to the decimal and duodecimal systems, looking, as it were, for the least common multiple of 10 and 12. But in spite of that the sailor divided his compass card in halves, N, S, E, NE, NNE, NNE by N, continually "splitting the difference" and reverting to primitive instincts.

This treatise is not a plea for any system, old or new; it

merely sets forth what I believe to be the fundamental mentality of the counting process, as I have seen it among primitive peoples, and as I have found it among white folks who had not been "educated" out of contact with reality and been seduced by that unlovely mistress, the number ten.—F. W. P.

The Education of Glass Technologists

From time to time the question is raised as to what should be the training, or as it is sometimes called (mistakenly, we think) the "education" of a glass man.

Until recently glass men were not educated at all; they acquired great skill; they were craftsmen of the first order; they were "trained," largely self-trained, and they had a fund of practical knowledge derived from long experience.

They were better off than most of their present day successors; better paid, better thought of in the community, and found their work more interesting. They were also more numerous a portion of the whole community.

Craftsmanship is a thing America has sacrificed on the altar of mass-production. It is a pity, for a new craftsmanship must now be re-created, for a craftsman is a finer product than a machine-minder, and an artist is worth more to the nation than strict uniformity in the necks of milk-bottles.

But a craftsman is not exactly what we mean by an educated man. His training is a long job, and his skill is wonderful, but though he do his work perfectly, he is no more of a craftsman or an artist than a naked greasy Bushman in the Kalahari desert, tracking the big game over the baked African plain, where a white man can see nothing to guide him at all. The little evil-smelling savage is just as much an artist in his line, has undergone an equally long apprenticeship, and has acquired as wonderful a skill, and as much perfection in his business, as any glassblower. He is just as well "educated." He is, in fact, a higher product than the machine-minders of a Detroit factory. He needs, and has, more resourcefulness, more courage, and a better sense of values than the people of Detroit.

And what is true of the unfortunate machine-minder is turning into a threat to the so-called scientific staff of the glass industry. We are even threatened with undergraduate schools of glass technology and ceramics, and these schools are to grant university degrees, and the product will be glass technologists and ceramists, but not men.

There may be room in the world for such a product, as there seems to be for drill-press operators, and there is at first sight no more reason against granting degrees of B. Sc. (Glass Technology) than there is against granting degrees of B. Sc. (Drill Press Operation) or B. Sc. (Big Game Tracking). We confess that we would prefer the last ourselves, but tastes may differ. Many of the most accomplished glass technologists of America believe that there should be no degrees granted or credits awarded in any subject so narrow as Glass Technology, and THE GLASS INDUSTRY is with them.

Many valuable men in the glass industry today may at some time or other have attended courses in Ceramics or Glass Technology, but it seems to us safe to say that these men owe their value to their ability—self-education rather than to any direct benefit obtained in their specialized scholastic work.

There is room for a good *school* in Glass Technology, even for undergraduate students, but the highest award should be a school diploma, not a University degree. There is room also for a post-graduate, or research course in Glass Technology, for the subject gets intricate in its later developments. Students for such a course should have graduated already in some broad field of science, and no degree lower than a Master's should be awarded for the course, which should be essentially a research course.

Only by some such arrangement as these can we prevent the growing up of a sterile race of narrow specialists. We need experts, even specialists, but they must first have a broad background. We must have educated men in the industry; we do not want a union of drill press operators.—F. W. P.

The Old Stone-Cracker

He used to sit by the side of the road, alongside his stone pile, whenever the sun was warm enough; below him in the distance, the white sails of the fishing smacks studded the green North Sea. The road, such as it was, had been there before the Romans came; you could get to Stirling castle, or even Edinburgh if you followed it long enough. But of course it was quicker and safer to go by sea. With hammer in hand the old man sat, and cracked the blue trap-rock down to two inch cubes or thereabouts, suitable for road material, and on Saturday the highway surveyor would come and measure his output and pay him for whatever he had done. He was way past seventy, and his needs were few. He worked when it was fit weather to be out and when he was fit enough himself, and he earned enough to warm his little cottage in the winter and to feed his meagre frame. Also it was company, for men passed up and down the road and passed the time of day with him.

He was not the only stone-cracker on the old Pictish road. At intervals of a quarter mile perhaps you would find stone depots and an old man sitting with his hammer, a hundred yards from his cottage, and earning his last few years of livelihood. And some old farmer with a couple of horses and two carts fastened in tandem, would come by at intervals and dump another load of the rough blue stone from the quarry on the knob. It was their way of taking care of the aged, and it took care of the roads at the same time.

A generation or more has passed since then. The roar of dynamite sends the blue cliff face in an avalanche to the quarry; snorting shovels send it crashing into dump cars. Roaring, clattering, battering crushers pour out a tonnage torrent of two inch cubes, and blundering lorries go whirling down the road with the finished product.

Old men no longer sit by the wayside. The manganese jaws of the great steel crusher produce more stone in a day than all the aged of the parish could produce in a month; and the man that drives the lorry has no time to pass the time of day. The road is wider, harder, smoother than ever it was, and folks in their motor cars go whirling down the Pictish road from Dundee to the sea.

They take care of the aged now with old age pensions. It

irks the proud Scottish spirit, but what would you? An old man cannot compete with Sir Robert Hadfield and his manganese steel. And the young folks that go flying down the steep hill-road with their bright-colored scarfs streaming in the wind are in no mood to stop and chat with an old man. It is enough to give an old fellow heart failure to see them shoot the long descent. For times have changed, and nowadays only a machine can earn its livelihood by working, but men must live on charity.—F. W. P.

(*Continued from page* 48)

An Apparatus for Determining Annealing Constants

By D. E. SHARP, JAMES BAILEY AND IRVING HYMAN, BAILEY & SHARP CO., HAMBURG, N. Y.

PRESENTED BY IRVING HYMAN

Reviewed by James Bailey

The paper disclosed an apparatus in which the glass to be studied was strained by mechanical means controllable at will by the operator. Specimens of glass were small and could be cut and prepared from ordinary commercial articles. The specimen was viewed by means of polarized light and its birefringence measured with a graduated quartz wedge. The rate of release of strain at various temperatures were thus measured. It was shown that data so obtained corresponded very closely with that of Adams and Williamson and that therefore their formula could be used in working out annealing schedules using the data obtained with this apparatus.

The method had the advantage of great rapidity as compared with the other methods.

Some Reflections on the Equilibrium of Glass Near the Liquidus

BY F. W. PRESTON, BUTLER, PA.

The writer points out that the viscosity measurements of English and others on glasses cover in most, perhaps all, cases, a range of temperatures that is partly above and partly below the liquidus temperature (highest temperature at which the glass will devitrify or throw out crystals). Thus the measurements relate in their upper range to a truly fluid glass and in their lower range to a pseudo-fluid or partially fluid one. Any attempt to find a scientifically acceptable law governing the connection of viscosity with the temperature should therefore begin by recognizing the existence of a change of state and follow by throwing out all non-liquidus determinations in the first analysis.

Possible double-refraction effects are suggested in specimens for a viscosity test.

The meaning of Dietzel's "Rate of Crystal Growth" is discussed, and some anomalies in his metastable crystallizations are pointed out.—F. W. P.

Fissures in Glass and Other Materials

BY F. W. PRESTON, CONSULTING ENGINEER, BUTLER, PA.

Note: The paper was given by title and reprints distributed among those present.

This paper pursues the conclusion reached in earlier papers that the details of glass fissures can be explained on the basis that the head of an advancing fissure endeavors at all times to stay at right angles to the principal tension in its immediate neighborhood. This argument is followed into some of its more complex manifestations, particularly into the complications of fissure-form that arise when the fissure-front splits, giving rise to hackle-textures and "stries" (feather patterns) on the one hand and to radiant-formation on the other.—F. W. P.

A Brief Analysis of Some Recent Data on the Impact Testing of Glass

BY F. W. PRESTON, BUTLER, PA.

This paper attempts to analyze results provided by Dr. Guyer and Mr. Sherwood, with a view to finding out if anything useful is being obtained from impact testing figures beyond what is gotten from static tests. It is shown that in general, with the aid of the rationalization proposed in a previous paper, the impact and static tests can be compared as a simple ratio, and that this ratio has a pronounced tendency to be constant for given conditions of testing.—F. W. P.

The Index of Refraction of Some Soda-Lime Glasses As a Function of Their Composition

BY C. A. FAICK AND A. N. FINN, BUREAU OF STANDARDS, WASHINGTON, D. C.

A series of soda-silica and soda-lime glasses were made, and their indices of refraction and chemical compositions were determined. From the data obtained curves showing the relations between index of refraction and composition were drawn. These curves make it possible to predict with considerable accuracy (1) the index of refraction of any glass in the series considered from its composition and (2) the compositions of the various glasses in the series having the same index of refraction.

Weathering and Iridescence of Some Ancient Roman Glass Found in Cyprus

BY A. W. LAUBENGAYER, ASS'T PROFESSOR, INORGANIC CHEMISTRY, CORNELL UNIVERSITY, ITHACA, N. Y.

Reviewed by James Bailey

Numerous graves of wealthy Romans have recently been discovered on the island of Cyprus. Various samples of glass removed from these tombs exhibit beautiful iridescence due to weathering. Some samples had been covered with silt and the portions of glass affected by weathering thus held in place. Examination of this layer and of the unaffected glass were studied spectroscopically.

On the Direct Determination of Soda in Soda-Lime Glasses

BY FRANCIS W. GLAZE, BUREAU OF STANDARDS, WASHINGTON, D. C.

Reviewed by F. W. Preston

A method for the direct determination of soda in soda-lime glasses is described. It depends on the quantitative precipitation of soda as uranyl zinc acetate and is based on the method described by Barber and Kolthoff. The advantage of this method lies in the fact that the sodium salt can be precipitated in the presence of the other basic oxides ordinarily present in soda-lime glasses.

A Progress Report on the Bureau of Standards Glass Research

BUREAU OF STANDARDS, WASHINGTON, D. C.

Based upon the work of Messrs. D. B. Lloyd and J. B. Saunders, detailed by the committee as Research Associates at the U. S. Bureau of Standards.

The paper is of highly technical nature covering a very wide field and cannot be briefly abstracted. Those interested are advised to obtain a copy of the original paper from the U. S. Bureau of Standards.

Exhibitors of Products, Equipment and Supplies

The exhibition of ceramic and glassmaking equipment and supplies in the lower section of the auditorium was one of the largest ever held in the history of the Society. Scores of exhibits were made, many of them by well known supply and equipment houses. With the exhibition of pottery and other products there were examples of very fine glass tableware and other products by the Cambridge Glass Company, Cambridge, Ohio, and the Fostoria Glass Company, Moundsville, W. Va., had a fine showing of tableware in the new neodymium color.

Those Registered in Glass Division

George Aurien	Mississippi Glass Co.
M. G. Babcock	Pittsburgh Plate Glass Co.
H. W. Bague	Corhart Refractories Co.
R. E. Barclay	Federal Electric Co.
James Bailey	Bailey & Sharp Co.
E. F. Ball	Ball Brothers Co.
M. L. Begeman	Mississippi Glass Co.

Henry L. Blau ..... Macbeth-Evans Glass Co.
Robert Bolan ..... General Electric Lamp Works
R. F. Brenner ..... Roessler & Hasslacher Chemical Co.
W. F. Brown ..... Libbey-Owens-Ford Glass Co.
C. B. Calder ..... Wilson-Maeulen Company
Wm. Clark ..... General Electric Lamp Works
Dr. Willi Cohn ..... Berlin, Germany
Geo. E. Connell ..... Harshaw Chemical Co.
G. W. Cooper ..... The Glass Industry
R. K. Day ..... Corning Glass Co.
R. M. Curts ..... American Potash & Chemical Co.
J. W. DeCamp ..... DeCamp Glass Casket Co.
W. C. DeCamp ..... DeCamp Glass Casket Co.
C. M. Dennis ..... American Potash & Chemical Co.
W. F. Dingley ..... Pacific Coast Borax Co.
Clarence Z. Eatherton ..... Buckeye Clay Pot Co.
Dr. Charles R. Essick ..... Pennsylvania Optical Co.
A. N. Finn ..... Bureau of Standards
F. C. Flint ..... Hazel-Atlas Glass Co.
J. Earl Frazier ..... Simplex Engineering Co.
Wilbur F. Gaunder ..... Pittsburgh Plate Glass Co.
Joseph W. Gill ..... Ohio State University
Weston H. Gillett ..... Macbeth Evans Glass Co.
Theodore W. Glynn ..... Blue Ridge Glass Co.
R. W. Goodwin ..... General Electric Co.
Robert S. Graetz ..... Adamston Flat Glass Co.
David E. Gray ..... Corning Glass Co.
S. S. Gregorius ..... Pittsburgh Plate Glass Co.
H. L. Haney ..... Harshaw Chemical Co.
Henry T. Hellmers ..... Cambridge Glass Co.
Kenneth M. Henry ..... Illinois-Pacific Coast Co.
Edwin L. Hettinger ..... Willson Products Co.
John V. Hoffacker ..... Corning Glass Co.
H. G. Hoffman ..... Brown Instrument Co.
M. K. Holmes ..... Hemingray Glass Co.
Benton Hopkins ..... H. K. Ferguson Co.
A. G. Hauser ..... Woods-Lloyd Co.
T. N. Hubbuch ..... American Potash & Chemical Co.
I. E. Hutchinson ..... Pennsylvania Salt Manufacturing Co.
Irving Hyman ..... Bailey & Sharp Co.
Herbert Insley ..... Bureau of Standards
Fred E. Jewett ..... Ball Brothers Co.
Frank L. Jones ..... Mellon Institute
John C. Kurtz ..... Bausch & Lomb Optical Co.
A. H. Klein ..... Norton Co.
Arthur Wm. Kimes ..... National Glass Budget
C. H. Kerr ..... Brown Instrument Co.
J. C. Kelly ..... Cambridge Glass Co.
A. W. Laubengayer ..... Cornell University
H. Lillie ..... Corning Glass Works
Dr. J. T. Littleton ..... Corning Glass Works
Garland Lufkin ..... Owen-Illinois Glass Co.
A. K. Lyle, Jr. ..... Hazel-Atlas Glass Co.
J. V. McCauley ..... Corning Glass Works
W. Malsch ..... Roessler & Hasslacher Chemical Co.
H. P. Margerum ..... Consolidated Feldspar Corp.
W. J. Mathews ..... Ohio Valley Clay Co.
J. B. Miller ..... Pittsburgh Plate Glass Co.
R. A. Miller ..... Pittsburgh Plate Glass Co.
John M. Neff ..... Bausch & Lomb Optical Co.
E. S. Newcomb ..... Leeds & Northrup Co.
Walter W. Oakley ..... Corning Glass Works
Theodore R. Oleni ..... McGraw-Hill Publishing Co.
W. L. Orme ..... Cambridge Glass Co.
F. W. Preston ..... Butler, Pa.
W. C. Rader ..... Feldspar Products Co.
Chas. H. Reese ..... Harding Glass Co.
Robert J. Rees ..... Corning Glass Works
Gerald Reinker ..... General Electric Co.
V. H. Remington ..... B. F. Drakenfeld & Co.
H. K. Richardson ..... Westinghouse Lamp Co.
L. C. Roche ..... Maryland Glass Co.
D. W. Ross ..... Findlay Clay Products Co.
S. R. Scholes ..... Fostoria Glass Co.
D. D. Schurtz ..... Lancaster, O.
M. R. Scott ..... Bausch & Lomb
Donald E. Sharp ..... Bailey & Sharp Co.
G. R. Shelton ..... Bureau of Standards
R. R. Shively ..... B. F. Drakenfeld
Alexander Silverman ..... University of Pittsburgh
C. D. Spencer ..... General Electric Co.
E. C. Sullivan ..... Corning Glass Works
V. C. Sevicker ..... Hartford Empire Co.
W. C. Taylor ..... Corning Glass Works
G. E. Thomas ..... Highland Fire Clay Co.
E. Ward Tillotson ..... Mellon Institute
Arthur E. Tool ..... Bureau of Standards
Jack H. Waggoner ..... Mellon Institute
H. L. Watson ..... General Electric Co.
W. F. Wenning ..... Ceramic Color & Chemical Mfg. Co.
Jos. W. Wright ..... Owens-Illinois Glass Co.
A. S. Zopfi ..... Buckeye Clay Pot Co.

Quite a number of visitors interested in glass, other than those who registered as above were on hand, including Irving E. Adams, who is actively engaged in consulting work in this field.

Plans to Form an Importers' Association

An effort is being made in New York by persons interested in foreign trade to organize an Importers' Association, the purpose being to support the importer in his daily work and to strengthen cooperation between the members in matters of general interest to all.

Since then, however, the projector of this idea, K. Lesser, of 500 Riverside Drive, New York, has stated that he has obtained the backing of a German trustee concern, the largest in its field, with 13 branch offices and 400 agents throughout Germany and other European countries. This concern is a legally qualified trustee. Outlining the advantages that would accrue from the formation of an organization as suggested Mr. Lesser points out that the Association represented by the large trustee concern in Germany would act there as the agent of the importer members, would assure the accurate fulfillment of their orders, would advise importers and manufacturers, would set up contracts to protect the importers, obtain credit information when desired, arrange for the cheapest and fastest transfer of the order contracts from the manufacturer to importer, make contracts with the forwarding company's shipping agents, etc. In fact, the same service which is being given at present to importers by individual agents, most of whom have less authority and not always equipped for this task. In the United States the service of the Association would include investigations as to best sales method efficiency in office management, the adoption of the best collection methods, and any other activities for the benefit of the trade which the importers might themselves desire to put into effect.

Correction Notice

We desire to call the attention of our readers to a regrettable omission which occurred in the October, 1930, issue of THE GLASS INDUSTRY, in which an article entitled "Glass Calculations Simplified," by R. R. Shively and V. M. Remington was printed.

In the introduction to that article, a statement was made to the effect that several years ago a paper similar to this was published by one of the writers and that in rewriting, the paper had been greatly enlarged and certain revisions made in the coefficient of expansion calculations as originally published.

Both the author and the editor, however, overlooked the fact that proper credit had not been given to a copyrighted article entitled "Principles of Glass Making" by the same author on the same subject, incorporating identical information which appeared in the June, 1924, issue of "The Ceramist," now known as "Ceramic Age," published by the Ceramics Publishing Company, Inc., Newark, N. J.

We desire, therefore, to make it plain to all that we greatly regreat this oversight and that full credit for the majority of the article repeated in our October, 1930, issue should be given to "Ceramic Age."

New Publication on Making of Mirrors

Circular of the Bureau of Standards No. 389 entitled "The Making of Mirrors by the Deposition of Metal on Glass" is now available. The publication is designed for the professional who is experiencing difficulty in silvering mirrors, and also for amateurs who are constructing reflecting telescopes, etc. For this reason, the various silvering formulæ and the technique of their preparation and use is given in great detail.

An interesting method of measuring the thickness of the film is described. The work has been extended to include the preparation of mirrors of metallic films other than silver, such as copper gold and platinum. A method of depositing lead sulphide for the production of a black mirror is of interest. Besides the chemical method, the formation of bright metallic films on glass by vaporization and high voltage "cathode sputtering" is described.

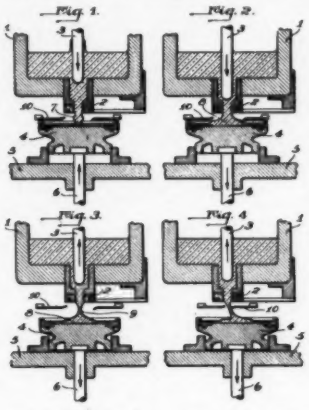
Copies of this publication can be obtained from the Superintendent of Documents, Washington, D. C., at small cost.

Recent Patents

NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C., Price 10c each

METHOD OF DELIVERING GLASS. U. S. 1,788,037. Jan. 6, 1931. Roy E. Swain, Charleroi, Pa. Filed 9/14/28. In the practice of the invention, glass is flown in a lateral unconfined stream from a container upon the central portion of the bottom of a mold which intercepts the stream and supports its lower end. The bottom of the mold and the discharge orifice of the container are maintained at such relative proximity that glass flows in a substantially straight line upon and spreads laterally from the central portion of the mold. At about the time sufficient glass has been thus charged into a mold, the distance between the mold and the orifice of the container is increased to neck, or in other words, diminish the cross sectional area of the stream of glass prior to severing it. By thus increasing the distance between the orifice and mold to neck a stream of glass, the severing shears pass through a relatively small diameter stream, and accordingly only small shears marks are formed on the severed ends of the glass. In thus severing the necked stream of glass, the lower shear blade throws the tail of the stream upon one side of the charge with the result that the shear mark is obliterated in pressing or otherwise forming the charge. To facilitate the throwing of a tail of glass upon the outer portion of a charge, the mold may be moved laterally with respect to the discharge orifice of the container simultaneously with, or just prior to, the operation of the shears. While either the glass container or the mold may be moved to effect the necking of a flowing stream of glass, it is preferred to move the mold.

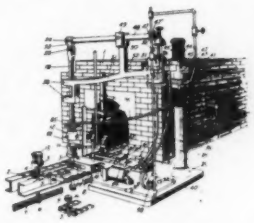


METHOD OF AND APPARATUS FOR ASSEMBLING GLASS BLANKS. U. S. 1,786,456. Dec. 30, 1930. Erich H. Rohl of Chicago, Ill., assignor to the Mantle Lamp Company of America. Filed 12/15/24. The invention embodies means for holding the outer blank in an inverted position during the performance of the process; means for holding the inner blank in an inverted position within the outer blank and concentric therewith until the shaping of the two blanks is complete and said blanks are autogenously welded together at their necks; means for synchronously rotating said blanks; and means for heating the pendent edges of said blanks to render them pliable while they are being molded; and, subsequently, to cause them to fuse and unite.

GLASS TANK. U. S. 1,780,164. Nov. 4, 1930. George W. Batchell, Toledo, O. Filed 6/29/29. In a glass tank formed of blocks, the side walls having courses of blocks located farther from the center of the tank than the courses above it a distance substantially equal to the thickness of the upper courses of blocks, the said upper courses of blocks located in proximity to and above the surface of the glass, a plurality of plates of metal located contiguous to the upper edges of the first named blocks and in spaced relation to parts of the lower sides of the last named blocks, and means for directing a cooling element between the surface of the said plates and the parts of lower sides of the said last named blocks.

GLASSWORKING APPARATUS. U. S. 1,784,763. Dec. 9, 1930. Merton A. Steelman, deceased, Vineland, N. J., by Anna M. Steelman, administratrix, Vineland, N. J., assignor to Hartford-Empire Company, Hartford, Conn. Original application filed 6/16/16. Renewed 10/29/24. Divided and this application filed 12/19/25.

APPARATUS FOR SHAPING ARTICLES OF GLASS. U. S. 1,775,965. Sept. 16, 1930. David L. Middendorf, Columbus, O., assignor to The Federal Glass Company, Columbus, O. Filed 11/26/26. In carrying out this invention, it is first necessary for the article to be partially shaped into what is commonly called a blank, this partial shaping being accomplished by pressing or blowing in a mold or by any other well known or applied means.



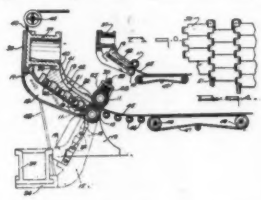
In shaping glassware, such as measuring cups, dishes, vases or other similar glass articles, in accordance with my method and with my apparatus I provide a suitable heating chamber to which the articles to be shaped are to be transferred. After the blank has been passed through the heating chamber and has been heated to the proper temperature and is in the desired plastic shape, a shaping means is caused to move upon the said plastic blank and forms the same to the desired shape. This action is accomplished automatically and without human intervention.

PROCESS FOR MAKING LAMINATED GLASS. U. S. 1,781,084. Nov. 11, 1930. James H. Sherts, Brackenridge and Robert E. Hamill, Tarentum, Pa., assignors to Duplate Corporation, Delaware. Filed 10/18/29.

A continuation of application, Serial No. 353,720, filed April 9, 1929. The object is to provide a treatment which will overcome an edge condition in which the celluloid is thinned and squeezed out and the glass bent slightly. This condition may later result in a separation at the edge due to the tendency of the bent glass to pull away from the celluloid. It may also result in the formation of slight cracks or lines in the glass running back from the edge a short distance and referred to as vents.

PROCESS FOR PREVENTING THE WEATHERING ESPECIALLY CLOUDING TARNISHING AND LUSTERING OF THE SURFACE OF GLASS. U. S. 1,782,169. Nov. 18, 1930. Kiyoshi Kamita, Ushigome-Ku. Tokyo, Japan, assignor to The Asahi Glass Company, Ltd., Tokyo, Japan. Filed 9/9/27 and in Japan 10/21/26.

APPARATUS FOR PRODUCING SHEET GLASS. U. S. 1,762,508. June 10, 1930. John L. Drake, Toledo, O., assignor to Libbey-Owens Glass Company, Toledo, O. Filed 10/24/28. One of the objects is to so improve the handling of the molten glass as it is transferred in the melting pot from the furnace to the rolling mechanism that its homogeneity will not be impaired and as a consequence of which the rolling of glass of high quality relatively free from streaks, bubbles and other flaws may be achieved. A further object of the invention resides in the provision of means for transferring the molten glass from the receptacle or pot to the rolling mechanism in such a manner that the glass will be kept in motion and will not contact with or lay idle upon the receiving table or support or upon any other surface which would tend to rapidly absorb heat from the glass and chill the same.



LAMINATED GLASS ARTICLE. U. S. 1,787,371. Dec. 30, 1930. Maurice C. Heaton, West Nyack, N. Y. Filed 6/27/28. A laminated glass article comprising a plurality of narrow strips of glass arranged in contact so that their side edges will form the respective faces of a panel, a layer of cement arranged between groups of said strips and a backing of cement covering one edge of all of said strips of glass, said backing merging into said layers of cement whereby all the parts are locked together.

GLASS PURIFICATION. U. S. 1,785,888. Dec. 23, 1930. George C. Cox, Raleigh, and Henry K. McIntyre, deceased, Raleigh, N. C., by Edna Moore McIntyre and John Gardiner McIntyre, New York, N. Y., and Malcolm McIntyre, Cranford, N. J., executors. Filed 10/5/26. Renewed 5/8/30. The primary purpose of this invention is the provision of a process for removing impurities (such as iron) from glass stock, and to provide a process wherein the stock may be kept molten when desired during the operation, even though the fusion point rises as the impurities are removed. The process comprises broadly the supplying of heat energy to the electrolyte by generating heat within the electrolyte of molten glass, it being found impractical to supply sufficient heat through refractory material to the electrolyte because of the necessity to maintain high temperatures to carry the process to a conclusion, direct current being passed through the electrolyte to bring about the electrolytic action and the reduction of the undesired metal from its compound or compounds.

It is proposed to supply this heat by means of electric current. This current may be alternating current to supply heat energy to the electrolyte by means of electrodes within the electrolyte chamber, which electrodes may be in contact with or below the surface of the electrolyte or they may, during operation, be slightly above the surface of the electrolyte, to cause an arc to be formed therebetween. If preferred, the energy may be furnished by an induction winding which, with or without a core, is so disposed as to generate heat within the electrolyte. If preferred, any two or more or all of the methods of heating the electrolyte may be used in the same furnace and under some conditions, it may be found to be desirable to use one or more forms during part of the operation and one or more of the same or others during another part of the operation for different conditions.

The direct current or electrolytic electrodes are preferably entirely independent of the alternating current electrodes or other heating means and are preferably arranged so the path of the direct current will be at a decided angle to the path of any conducted or induced heating current.

FEEDING MOLTEN GLASS. U. S. 1,781,340. Nov. 11, 1930. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 11/3/24. One object is to provide an apparatus for feeding molten glass wherein the glass is caused to issue through a downwardly opening discharge outlet and is provided with internal support by means of a stationary implement around which the glass flows while it is issuing from the outlet. The adhesion of the glass to this implement furnishes support to the issuing glass in addition to the support afforded by the walls of the outlet, and the provision of such additional support permits larger and longer mold charges to be severed in suspension and at slower speeds than would be possible without the internal support.

GLASSWARE FORMING MACHINE. U. S. 1,783,201. Dec. 2, 1930. Leonard D. Soubier, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo O. Filed 6/30/27.

GLASSWARE-ANNEALING LEER. U. S. 1,783,208. Dec. 2, 1930. Percy Q. Williams, Toledo, O., assignor to Owens-Illinois Glass Company, Toledo, O. Filed 8/16/26.

PROCESS AND APPARATUS FOR REGULATING THE TEMPERATURE OF GLASS WITHDRAWN FROM A TANK. U. S. 1,783,473. Dec. 2, 1930. Harry F. Hitner, Oakmont, Pa., assignor to Pittsburgh Plate Glass Company. Filed 2/4/29.

APPARATUS FOR HANDLING GLASSWARE. U. S. 1,783,939. Dec. 2, 1930. John E. Schroder, Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 10/13/27.

APPARATUS FOR MAKING COMPOSITE GLASS. U. S. 1,783,985. Dec. 9, 1930. James H. Sherts, Brackenridge, Pa., assignor to Duplate Corp. Filed 1/22/29.

APPARATUS FOR CUTTING SHEET GLASS. U. S. 1,785,496. Dec. 16, 1930. Clifford A. Rowley, Toledo, O., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 5/19/24.

DRAWING SHEET GLASS. U. S. 1,785,497. Dec. 16, 1930. Clifford A. Rowley, Chicago, Ill., and Joseph A. Reece, Toledo, O., assignors to Libbey-Owens-Ford Glass Co., Toledo, O. Filed 9/23/26.

LEHR FEEDER. U. S. 1,785,534. Dec. 16, 1930. Irving Simonis, Toledo, O., assignor to Owens-Illinois Glass Co., Toledo, O. Filed 4/12/28.

METHOD OF FORMING THIN-WALLED GLASS ARTICLES. U. S. 1,785,535. Dec. 16, 1930. Theodore H. Sloan, Charleroi, Pa., assignor to Macbeth-Evans Glass Co. Filed 9/28/29.

PROCESS OF PREPARING COMPOSITE GLASS FOR SEALING. U. S. 1,785,099. Dec. 16, 1930. James H. Sherts, Glen Ridge, N. J., assignor to Duplate Corp. Filed 5/26/28.

RADIANT READING PYROMETER. U. S. 1,788,849. Jan. 13, 1931. Julius Schunemann, Bad Homburg, Germany, assignor to Hartmann & Braun Aktiengesellschaft, Frankfort-on-the-Main, West, Germany. Filed 12/16/27 and in Germany 12/24/26.

GLASS-WORKING MACHINERY. U. S. 1,788,927. Jan 13, 1931. George A. Millar, Ridgefield Park, N. J., assignor to General Electric Vapor Lamp Company, Hoboken, N. J. Filed 2/26/27.

GLASS-WORKING MACHINE. U. S. 1,788,926. Jan. 13, 1931. George A. Millar, Ridgefield Park, N. J., assignor to General Electric Vapor Lamp Company, Hoboken, N. J. Filed 5/24/26.

SHEET-GLASS SURFACING APPARATUS. U. S. 1,788,931. Jan. 13, 1931. Ingvald O. Pedersen, Pittsburgh, Pa., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 10/25/26.

GLASS-WORKING MACHINERY. U. S. 1,788,954. Jan. 13, 1931. Roy D. Mailey, East Orange, and Wilford J. Winninghoff, South Orange, N. J., assignors to General Electric Vapor Lamp Company, Hoboken, N. J. Filed 11/28/25.

GLASS-WORKING MACHINE. U. S. 1,789,014. Jan. 13, 1931. George A. Millar, Ridgefield Park, N. J., assignor to General Electric Vapor Lamp Company, Hoboken, N. J. Filed 12/28/26.

METHOD AND APPARATUS FOR MAKING ARTICLES OF GLASSWARE. U. S. 1,781,565. Nov. 11, 1930. Robert J. Beatty, Columbus, O., assignor to The Federal Glass Company, Columbus, O. Filed 3/13/28.

METHOD AND APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,781,452. Nov. 11, 1930. Enoch T. Ferngren, Toledo, O., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 3/20/22.

FEEDING MOLTEN GLASS. U. S. 1,781,340. Nov. 11, 1930. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 11/3/24.

MANUFACTURE OF BLOWN-GLASS ARTICLES. U. S. 1,781,233. Nov. 11, 1930. Sydney Hunt, Birmingham, England, assignor to John Walker & Sons, Limited, London, England. Filed 9/3/27. and in Great Britain 6/22/27.

PROCESS FOR MAKING LAMINATED GLASS. U. S. 1,781,084. Nov. 11, 1930. James H. Sherts, Brackenridge and Robert E. Hamill, Tarentum, Pa., assignors to Duplate Corporation, Delaware. Filed 10/18/29.

GLASSWARE-FORMING MACHINE. U. S. 1,787,635. Jan. 6, 1931. James W. Lynch and Edward G. Bridges, Anderson, Ind., assignors to Lynch Corp. Filed 12/6/24.

GLASS-BLOWING MACHINE. U. S. 1,788,312. Jan. 6, 1931. James W. Lynch, Alexandria, Ind. and Edward G Bridges, Zanesville, O., assignors to Lynch Corp. Filed 6/4/17.

APPARATUS FOR GATHERING GLASS. U. S. 1,785,209. Dec. 16, 1930. Karl E. Peiler, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 4/21/25.

FEED MECHANISM FOR GAS PRODUCERS. U. S. 1,785,789. Dec. 23, 1930. John F. Rogers, Cleveland Heights, O., assignor to The Wellman Engineering Company, Cleveland, O. Filed 8/1/27.

Owens-Illinois Catalog Marks Epoch In Container Business

A regular "granddaddy" of a catalog devoted exclusively to the Owens-Illinois Glass Company of Toledo and its products has recently been distributed widely throughout the glass container trade. This massive book, containing approximately 500 pages, is impressive not only by reason of its size and completeness but because it is so excellently produced and unique in many ways. It is doubtful if its equal could have been reproduced by any concern of smaller facilities and resources than the great organization which has compiled and published it. It is printed on fine coated paper and the hundreds of illustrations, many of them in colors, show designs of machine-made and hand-blown containers for every imaginable purpose.

On the first page it is pointed out that the volume is more than a catalog, that it is dedicated to the users of glass everywhere, that it contains much of interest and beauty and many practical solutions for all sorts of packaging problems. This is followed by a brief outline of the company's facilities for service, and ability and willingness to be of assistance to users of glass.

The catalog is designed to live for a period of years. A brief history of the company occupies two pages and a statement of its policies follows. A colored map showing the location of the company's 20 sales offices and 20 manufacturing plants is shown. To demonstrate the company's facilities for service the reader is taken on a "word and picture tour" of one of the modern Owens-Illinois factories. It is pointed out to him that while "from sand with cement as a binder, man fashions attractive building materials and enduring roadways and while from a finer quality he grinds tons of talcum which adds bloom to the cheeks of the fair, the greatest of his accomplishments in sand is as it emerges from a metamorphosing furnace—in clear, brilliant, transparent, glass."

The tour starts in a tunnel beneath the series of tremendous storage bins from which the sand and other raw materials are gathered and from which electrically driven batch cars collect the sand, soda ash and lime and mix it thoroughly before it is conveyed to the melting furnace. All of the weighing work and other operations are performed automatically. The furnace is then visited (in the reader's imagination) and the entire operation of glassmaking is briefly described. This part of the book is decorated with novel color illustrations of some of the interesting phases of the process. After the furnace, the electric lehrs are examined. "At the cold end of the lehr where the finished bottles emerge, 'Sue and her sisters' enter into the drama of bottle products." Women as inspectors have proven to be far better selectors than men. They possess a keenness of eye and nicety of selection men sometimes lack. They are quick and deft.

From the factory the sightseer turns to investigate the increasingly famous role which role science now plays in glass production and bottle manufacture. He is told how only 25 years ago nearly all bottles were blown by hand and little or no attention was paid to the purity of the raw materials. The result was a great variation in the quality of the glass and the customer had no assurance of a uniform and dependable supply of bottles. Old glass blowers, when the melting conditions in the furnace became unsatisfactory, would throw a large potato into the molten glass. This was not as silly as it sounds nor can the result be regarded as a phenomenon. It was simply a demonstration of the workings of the laws of chemistry. The fact is that a chemical reaction took place when the potato fell into the seething glass, which permeated the entire mass somewhat in the manner of the ever-widening ripples caused by a stone thrown into water. The glassblower did not realize, during the agitation, that he was performing a chemical operation. The dissolved gases in the solution came to the surface and the result was a cleaner and less blemished glass. The potato method does not fit into modern practice and new scientific instruments and technically trained men became necessary. Like all the larger glass manufacturers nowadays chemical (and frequently mechanical engineering) laboratories are maintained by Owens-Illinois for production control and research purposes. Large sums are spent in research, in the testing of raw materials and the finished glass, as well as in improving all of the operating methods involved.

Only those familiar with the remarkable progress made in glass manufacture during the past 25 years have any adequate conception of the marvelous advances that have been made.

A department of design is maintained by the company. Illustrations of many of the company's plants are shown. Different types of molds are illustrated.

A large part of the book is given up to data and illustrations of the innumerable types of bottles and other glass containers made by the company. Selecting the right type for his purpose is made easy for the buyer. This section goes into infinite detail. The first tabulation is the proprietary pharmaceutical division, next comes hand-blown ware, the prescription division, food container division, large ware division, beverage bottle division, milk bottle division, package division. The company owns its own paper mill at Carlyle, Illinois. Here from raw straw the great rolls of paper are produced and are later processed and assembled to make corrugated packing material of the highest quality. Both paper and wood cases for any purpose are manufactured in the company's plants.

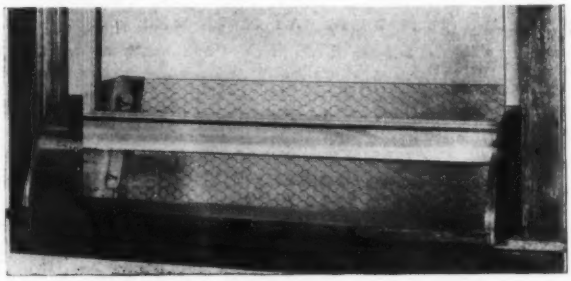
In the catalog the vital question of "tolerance" in containers and closures is discussed. Standard glass finishes are illustrated and described and the book is concluded with a description and illustrations of standard seals and enclosures. An elaborate index identifies the items manufactured, by mold numbers. The book is handsomely and strongly bound in looseleaf form, in leather finish with silver decorations. New pages showing advances made in design and production of the different types of containers will be furnished by the company from time to time and can readily be inserted in the metal binder which holds the pages in their proper place. The catalog as a whole is a splendid example of the modern way in which an enterprising concern can put before its customers and prospective buyers in most convenient form the important facts regarding its products. The big book was produced in the Toledo plant of The Roberts Printing Company, and the Detroit plant of The Commercial Bindery, Inc.

Glass Window Muffler Reduces Noise and Eliminates Drafts

By C. W. GEIGER[1]

Glass window mufflers are now being used successfully in San Francisco to reduce the noise entering open windows which face a busy street. This muffler not only reduces the noise entering through an open window but at the same time there is sufficient window opening to keep the air fresh at all times.

Practically the total volume of street noises come through the window opening, and strikes the occupants, particularly those stationed near the windows, before striking the walls and ceiling. The function of the glass window muffler is, as the name implies, to reduce the intensity of the noise coming through the opening. This is accomplished by reflecting the bulk of sound waves back into the street, the residue which finally enters the room through the air opening being very much weakened, and is directed away from direct contact with the occupants. The window muffler does



WINDOW MUFFLE

Consisting of two glass reflectors, one inside of window made of plain glass and one outside window made of wire glass as shown in this photo. This photo also shows the proper position of the lower edge of the sash.

not interfere with the free passage of air. The latter is deflected upward as a gentle draft and as a result does not blow directly on the occupant as is the case with an unmuffled window. This window muffler is being used in hotels, hospitals, office buildings and all classes of buildings facing busy and noisy streets.

Observations of several parties in whose offices window mufflers have been installed have been that from fifty to seventy-five per cent of the noise is eliminated. The actual figure is difficult to

[1]Union League Club, San Francisco.

determine. There is a greater proportion of the high pitch noise of short duration kept out than the low pitch sustained noise. For example, one can hardly hear the exhausts of automobiles through the muffled opening, while the grind of street car gears is still heard fairly distinctly. The latter sound is transmitted through the glass, being of sufficient duration that some section of the window pane can resonate.

The chief cause of annoyance and interference with telephoning and other conversation, is found in the higher pitch ranges, and these are effectively subdued by the glass window muffler.

As shown by the accompanying photo the window muffler consists of a combination of inside and outside glass reflectors, placed at the bottom of the window, the height of reflectors being about twice the amount of opening.

The Glass World and What It Is Doing

News of the Industry

Changes in Canadian Customs Act

Recent changes made in the Canadian customs act include a certain portion of the certificate shown on the Customs invoice on which alterations have been made. The general tariff provides as follows:

(4) That the said invoice also exhibits the fair market value of the said goods at the time and place of their direct exportation to Canada and as when sold at the same time and place in like quantity and condition for home consumption, in the principal markets of the country whence exported directly to Canada and that the said fair market value,—

(a) Is not lower than the selling price of such goods when sold to jobbers or wholesalers generally at the said time and place;

(b) In the case of new or unused goods is not lower than the actual cost of production of similar goods at the same time and place, plus a reasonable advance for selling cost and profit;

(c) Is without any discount of deduction not shown and allowed on invoices covering sales for home consumption in the country of export in the usual and ordinary course of trade; and

(d) Is without any deduction on account of any drawback or bounty or on account of any royalty actually payable thereon or payable thereon when sold for home consumption, but not payable when exported, or on account of the exportation thereof, or for any special consideration whatever.

Glass Men Enjoyed Interesting Trip

Further details of the trip mentioned in the February issue made by Edward Miller and Andrew G. Doll of the Miller Machine & Mold Works, Columbus, O., became available just too late for insertion in that number.

Mr. Doll reports that the trip was a very pleasant one. The first stop was at Port-au-Prince, Haiti. A day was spent there and the next stop was at Kingston, Jamaica, where another day was put in seeing the sights. From there the party went to Colon, Panama, through the Canal via boat to Panama City. The return was made by train and they then sailed direct for Cuba. While at Havana the group visited the Fabrica de Botellas "Bacardi" plant but missed meeting George Aiken who for the past two years had been in charge of that factory. Mr. Aiken's two-year contract with the company expired in September and in view of the unsettled political conditions in Cuba and the fact that the Company had a year's stock of milk bottles on hand it was decided to curtail production. Mr. Aiken has returned to the United States and has been calling on old friends in various places, including THE GLASS INDUSTRY.

Mr. Doll reported that the "Bacardi" factory is a very nice plant, using oil as fuel. Their principal product is narrow-necked bottles using Hartford feeders, O'Neill machines, and Simplex lehrs, and on one of the Miller Model "M" 8 Mold (Motor driven) machines they make milk bottles. At the time the visit was made to the factory they were operating one of the O'Neill machines making "Bacardi" rum bottles of the push-up bottom type. This bottle is difficult to produce due to the fact that there are two separate operations in its manufacture.

The next stop was made at Nassau which is a very pretty island where sponges and fishing are the chief industries. While on this trip Mr. Doll made it a point to check the tumblers served at the hotels, beer gardens, and other refreshment resorts. He stated that he could truthfully say that Hocking Glass and Federal Glass tumblers made on Edward Miller machines were used in every country the party visited.

Mr. Doll on his return also reported that the year 1930 was by far the best year for business Miller Machine & Mold Works have ever experienced. More than three times as much business was done as during the previous year. The Miller party stopped at New York on their way home and called on a number of manufacturers and exporters while in the city. They found the outlook very encouraging. They arrived back at their office with Mr. Miller all ready to develop some new ideas he has evolved about tumbler manufacture. They found that their factory was operating at full capacity and at the end of January they had on hand sufficient orders to keep the plant busy for the next ninety days.

George Aiken With Us

George Aiken, who for the past two years has been in charge of the plant in Cuba manufacturing "Bacardi" bottles, on expiration of his contract recently left that island for a visit to one or two of the Latin-American countries after which he returned to New York and is now visiting old friends in the Pittsburgh and other glass districts. Mr. Aiken when in New York intimated that he was undecided as to whether he would stay in the United States or again connect with some foreign glass plant.

Tariff Hearing on Window Glass Postponed

Public notice was given by the U. S. Tariff Commission on February 4 that the investigation of window glass which had been set to begin on March 10, 1931, had been postponed until May 15, 1931. This is investigation No. 20 covering cylinder, crown and sheet glass by whatever process made and for whatever purpose used. No explanation was given as to the reason for postponing the hearing.

On January 13 the Senate confirmed President Hoover's nominations of Edgar F. Brossard, and Lincoln Dixon who was the only remaining nominee for the Commission and whose appointment was confirmed without debate or a record vote.

The Commission also announced some time ago a hearing at Washington on March 24 regarding import duties on table and kitchen articles and utensils wholly or in part value of glass blown or partly blown.

January Production of Polished Plate Glass

The production of polished plate glass in the United States for the month of January, 1931, compiled by P. A. Hughes, secretary of the Plate Glass Manufacturers of America, was 7,320,675 sq. ft., as compared to 4,941,405 sq, ft. produced in the preceding month, December, 1930, and 10,017,909 sq. ft. produced in the corresponding month last year, January, 1930.

Pressed and Blown Glassware Meeting

The National Association of Manufacturers of Pressed and Blown Glassware will hold their annual meeting at their office, 316 House Building, Pittsburgh, on Tuesday, March 10, to be immediately followed by a joint conference with the workers to adjust a number of disputes which it was not possible to settle locally.

C. H. Van Tine Joins Dresser Company

It has just been announced by the Dresser Company, engineers and builders, Cleveland, O., that C. H. Van Tine, formerly of the DeVore Company, Toledo, O., and later with The H. K. Ferguson Company, has become connected with their organization and will be in charge of their glass plant design and construction.

Glassware Manufacturers Schedule July Meeting

The American Glassware Manufacturers, Inc., have set Monday, July 13, as the date of their annual meeting to be held at Atlantic City, N. J. This date is set provisionally with the idea that should an earlier meeting of the Association become necessary, an announcement to that effect will be made by the organization's secretary, John Kunzler.

The Wellman Mechanical Gas Producer, a new 20-page descriptive bulletin 92, describing and illustrating the Wellman producer and some of its special features, such as the double bell feed, its water cooled poker, its intermittent testing and loosening device in the ash zone. This producer is completely mechanical in all of its functions and automatic from infeed of coal to ash disposal. Constructional details are illustrated and data is given on operating costs for a glass factory, rolling mill, steel foundry, sheet steel mill and a brick yard. The relative costs of producer gas, natural gas and fuel oil are discussed as are various other subjects of interest to gas producer operators. In addition to gas producers the company builds valves, gas flue systems, special purpose cranes, electric hoists, and maintains an experienced and efficient engineering department.

Trade Activities

The Weaver Glass Company, 227 Eddy Street, Providence, R. I., formerly known as the H. C. Luther Company are now operating under the new name.

C. P. Fritzsche & Co., Inc., of Richmond, Va., has been incorporated with a capital of $50,000 by C. P. Fritzsche, 3500 Grove Avenue, to manufacture glass.

The Capitol Glass Company, Inc., Indianapolis, Ind., has been incorporated to deal in glass products of all kinds, by Wm. J. Clementine, and Robert W. Byrne.

W. M. Jacobs has been appointed by Pittsburgh Plate Glass Company to be superintendent of Plant No. 6, succeeding Lee Showers who has been appointed as general manager of the company's window glass plants located at Clarksburg, W. Va., Mt. Vernon, O. and Henrietta, Okla.

The Northern Blower Company, Cleveland, O., has appointed C. H. Keeney to be sales manager for their line of exhaust fans and systems, suction filters, sandblast rooms, dust collecting systems and kindred products. Mr. Keeney has been identified with this line of manufacture for 25 years.

R. D. Wood and Company, 400 Chestnut Street, Philadelphia, Pa., designers and builders of the Wood Mechanical gas producer, recently added to their line the Mathews Modernized Hydrant. Large factories which operate water systems for fire protection and other purposes may find this circular of interest.

The Pittsburgh Plate Glass Company, Pittsburgh, Pa., have arranged with Stone & Webster Engineering Corporation, Laughlin Building, Los Angeles, Cal., to have soil tests and surveys made for a new sheet glass manufacturing plant on property owned by the company at Santa Ana, Cal. The plant will include a machine shop, power house and other structures. The total investment, it is reported, will eventually run into millions of dollars.

Recent Deaths

A. Hart McKee

A. Hart McKee, son of the late H. Sellers McKee, prominent in the glass manufacturing industry in earlier days and who later towards the end of the last century established a plant at Jeannette, Pa., died at New York on February 24.

Franklin M. Beggs

Franklin M. Beggs, service manager of the Morgantown Glass Works, Morgantown, W. Va., who has been in ill health for a long time but who continued faithfully at his work until recently, died in that city on February 20 at the age of 49. Previous to his connection with that company he was for 20 years connected with the United States Glass Company and later with the Monongah Glass Company preceding his recent connection with the Morgantown Glass Works.

O. M. Byers

O. M. Byers assistant superintendent of the American Window Glass Company's plant at Jeannette, Pa., died February 27 as the result of a 15-foot fall through a hole into a cold furnace which was undergoing repairs. Mr. Byers was 50 years of age. He was a graduate of the University of Pittsburgh and had been connected with the American Window Glass Company for 26 years.

Coming Meetings

Thirteenth Exposition of Chemical Industries, Grand Central Palace, New York, week of May 4, 1931.

National Association of Manufacturers of Pressed and Blownware, Pittsburgh, Pa., March 10, to be followed by joint conference with workers.

The International Congress on Illumination will be held in Great Britain during the period from September 2-19, 1931. Technical sessions will be held in several different cities, the first in Glasgow, Scotland. Numerous illuminating engineering associations will hold meetings on various dates and at various places. Those desiring to attend the Congress are requested to get in touch with the Illuminating Engineering Association, 29 W. 39th Street, New York.

Inquiries Received

For further information address THE GLASS INDUSTRY.

536. We are in the market for a 3" bubble ball and will appreciate it very much if you will inform us where we may obtain such a ball.

537. I want to locate a glass company that can make up a special glass tubing.

What The World Wants

Specific Inquiries for American Goods Received in the Department of Commerce, Washington, D. C. For further information write the department.

Canada—50253. Bottles, milk.
England—20230. Glass confectionery jars.
Malta—50197. Glass roofing.
Siam—50237. Glass screens for motor boats.
Canada—50227. Glassware, household, plain and decorated.
Argentina—50082. Glass, including stained, prismatic and beveled.
Porto Rico—50139. Glass letters, opaline, for electric signs.
Canada—50023. Glassware.
Italy—49935. Glass, unbreakable for automobiles.
Ecuador—49990. Glassware.
Germany—49658. Glassware, office (desk sets).
Hungary—49751. Glassware, pressed, household, ornamental, and bric-a-brac; cut glass, and table and kitchen porcelain.
Brazil—49758. Inkwells, glass.

Readers Wants and Offers

Address answers to all "keyed" ads c/o The GLASS INDUSTRY 24 West 40th St., New York

GLASS TECHNOLOGIST OFFERS SERVICES

A Glass Technologist now holding a position as superintendent desires to make a change.

Forty-six years of age, always inventive and understands how to supervise a plant from batch mixing to the shipping room; also have experience in Decorating and Designing.

A position with a reliable concern only will be considered.

Address "Class M1" as above.

Current Prices of Glass-Making Materials

February 24, 1931

Quotations furnished by various producers, manufacturers and dealers.

		Carlots	Less Carlots
Acid			
Citric (dom.)	lb.	.40	40
Hydrochloric (HCl) 20° tanks, per 100 lb.		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	..	.13½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	..
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	..
Tartaric	lb.	..	.31½
Alcohol, denatured	gal.	..	.52
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb.	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.19
Ammonia water (NH_4OH) 26° drums	lb.	.03	.03¼
Antimony, metallic (Sb)	lb.	..	.09½
Antimony oxide (Sb_2O_3)	lb.	..	.09⅝
Antimony sulphide (Sb_2S_3)	lb.	..	.14
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	47.00	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05-.05½
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	.08	.08¼
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	..	.0355-.0425
Crystal	lb.	.028-.033	..
Granulated	lb.	.025-.03	..
Powdered	lb.	.02875-.03375	..
Boric acid (H_3BO_3)	lb.	.0625-.07125	.06-.08125
Refined	lb	0625-.07125	.07125-.08125
Cadmium sulphide (CdS)—			
Red	lb	..	.65-.90
Orange	lb	..	.65-.90
Yellow	lb	..	1.30-1.50
Chromium oxide (Cr_2O_3)	lb.	.24	.26
Cobalt oxide (Co_2O_3)			
In bbls.	lb	..	1.75-1.85
In 10 lb. tins	lb	..	1.85
Copper oxide			
Red (Cu_2O)	lb	..	.25
Black (CuO)	lb	..	.18-.25
Black prepared	lb	..	.22
Cryolite ($Na_3Al F_6$) Natural Greenland Kryolith)	lb	.09	.10-.10½
Synthetic (Artificial)	lb.		.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb		..	1.15-1.20
Feldspar—			
100 mesh	ton	12.00-18.00	13.50-2.00
80 mesh	ton	11.00-11.75	14.50
40 mesh	ton	11.00	13.50
20 mesh	ton	10.00	10.50
Fluorspar (CaF_2) domestic, ground, 95-98% (max SiO_2 2½%)			
Bulk, carloads, f.o.b. mines	ton	32.50	..
In bags or barrels	ton	36.50	41.50
Imported	ton	36.50	38.50-40.00
Formaldehyde	lb	..	.07½-.07¾
Graphite (C)	lb	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb	..	.0450
Black (FeO)	lb	.04½	..
Kaolin (f.o.b. mine)	ton	8.00-9.00	..
English, lump, f.o.b. New York	ton	14.50-25.00	24.50-30.00
Kryolith (see Cryolite)			
Lead chromate ($PbCrO_4$)	lb	..	30
Lead oxide (Pb_3O_4) (red lead)	lb.	.710-.09¼	.08
Litharge (PbO)	lb.	.610-.08¼	.07
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	7.75	..
Burnt (CaO) ground, in bulk	ton	6.00	..
Burnt, ground, in paper sacks	ton	8.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15	2.30
Limestone ($CaCO_3$)		1.75-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	..	.23
extra light (in bbls.)	lb.	..	.27
Magnesium carbonate ($MgCO_3$)	lb.	.06	.07-.10½
Manganese 85% (MnO_2)	lb.	.03	.03
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb	.09	.09¼
Ground	lb	11	.12
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb.	.06½	.07¼
Hydrated 80-85%	lb.	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.23-.32
Potassium hydrate (KOH) (caustic potash)	lb.	.07⅛	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.06½-.06¾
Potassium permanganate ($KMnO_4$)	lb.	.16	.17
Powdered blue	lb.	..	.23
Rochelle salts, bbls.	lb.	..	.19
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb	..	1.80-1.90
Silver nitrate (AgNO.) (100 oz.)	per oz.	..	.24
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.07½	..
In barrels	Per 100 lb.	1.38	1.90-2.00
In bags	Per 100 lb.	1.17½	1.72½
Spot orders .025 per 100 lbs. higher		..	..
Sodium bichromate ($Na_2Cr_2O_7$)	lb	.07	.07½
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.50	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03⅞	.04½
95 per cent.	Per 100 lb.	2.01½-2.08	2.15-2.25
Sodium selenite (Na_2SeO_3)	lb.	..	2.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.05	.05½
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	..	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb	3.45	3.80-4.00
Flowers, in bags	Per 100 lb	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb.	.37½	.39
Tin oxide (SnO_2) in bbls.	lb.	.28	.30-.35
Uranium oxide (UO_3) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	..	2.75
Yellow	lb.	..	1.50
Zinc oxide (ZnO)	lb.	.03½	.12
American process, Bags	lb.	.06½	.07
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½-.08
Crude, Gran. (Milled .005-.02c higher)		03½	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to January 24, 1931

	December 1929 Quantity	December 1929 Value	December 1930 Quantity	December 1930 Value	Twelve Months Ending December 1929 Quantity	Twelve Months Ending December 1929 Value	Twelve Months Ending December 1930 Quantity	Twelve Months Ending December 1930 Value
Glass and glass products (Total)	.....	$842,557	.....	$596,677	.....	$10,931,119	.....	$9,020,046
Plate and window glass—								
Window glass, common, box 50 sq. ft.	367	2,541	762	3,754	15,533	91,909	15,544	84,014
Plate glass, unsilvered, sq. ft.	185,798	70,776	192,459	51,726	2,042,650	745,379	3,361,408	1,035,759
Other window and plate glass	lbs. 402,394	35,139	332,987	25,537	5,778,188	512,818	5,188,662	443,446
Glass containers (bottles, vials and jars)	.....	251,570	.....	208,354	.....	3,570,167	.....	2,992,326
Table glassware, plain	.....	137,171	.....	75,305	.....	1,523,447	.....	1,101,188
Table and other glassware, cut or engraved	.....	16,881	.....	7,486	.....	135,365	.....	96,709
Lamp chimneys and lantern globes	lbs. 76,605	16,836	55,083	9,921	1,581,218	319,502	1,180,769	217,530
Globes and shades for lighting fixtures	lbs. 169,930	62,429	104,859	40,671	2,080,253	749,820	1,586,032	582,020
Chemical glassware	lbs. 25,259	25,195	20,755	16,425	290,072	249,076	269,244	230,760
Electrical glassware, except for lighting	lbs. 146,023	14,427	81,317	6,222	4,872,988	406,042	3,462,055	239,054
Other glassware	.....	209,592	.....	151,276	.....	2,627,594	.....	1,997,240

IMPORTS

Corrected to January 24, 1931

Glass and glass products	.....	$879,242	.....	$605,571	.....	$13,992,792	.....	$8,939,907
Cylinder, crown and sheet—								
Plain	dut. lb. 2,110,919	97,149	667,007	25,455	66,819,268	2,184,595	14,670,243	572,929
Bent, beveled, colored, etc.	dut. lb.	43,122	.....	20,562	.....	564,007	.....	345,737
Made into mirrors	dut. sq. ft.	.....	18	148	.....	.....	[2] 427	[2] 1,048
Plate glass—								
Plain	dut. sq. ft. 815,793	157,536	647,131	155,987	10,952,783	2,256,897	5,297,590	1,081,946
Bent, beveled, colored, etc., and mirrors	dut. sq. ft. 335,476	50,311	4,862	3,633	1,827,385	362,623	577,341	188,898
Rolled cylinder, crown, and sheet glass, ground, obscured, bent, beveled, colored, etc.	dut. sq. ft.	.....	.....	6,947	.....	.....	.....	[2] 29,036
Laminated and plated glass	dut.	.....	.....	1,315	.....	.....	.....	[2] 13,868
Bottles, vials, jars, and other containers	dut.	69,460	.....	68,939	.....	308,382	.....	1,138,381
Scientific articles and utensils	dut.	42,792	.....	24,921	.....	647,679	.....	502,486
Tubes and rods	dut.	.....	.....	8,045	.....	.....	.....	[2] 52,285
Illuminating articles	dut.	52,702	.....	44,379	.....	801,852	.....	601,895
Blown glass articles	dut.	246,195	.....	151,121	.....	5,104,105	.....	3,102,245
Pressed glass articles	dut.	17,985	.....	12,444	.....	281,823	.....	205,650
Other glassware	dut.	101,990	.....	81,675	.....	1,480,829	.....	1,102,503

[2] Beginning June 18, 1930.